FRAUD AND CREATIVE ACCOUNTING: A TWIN CHALLENGE TO USERS OF FINANCIAL INFORMATION

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Abstract
Users of financial information rely on the financial statements produced by the management of the organizations. These financial statements, before being released to users are supposed to be certified by the auditors. However, with the recent corporate scandals around the world and Nigeria inclusive, one is left to wonder whether these financial statements reflect a true and fair view of what transpired in the organization within the accounting year. This paper looks at fraud and creative accounting as a challenge to accurate financial reporting. The effects of this challenge were also highlighted both on the users of the financial information and the practitioners of the Accounting profession. The paper concludes with adequate recommendation to help solve this twin challenge.

Introduction
The Companies and Allied Matters Act 1990 sections 331-335, requires that companies operating in the private sector (PLCs and Limited Liability Companies) prepare their financial statements annually. Such financial statements must be certified by an auditor before being presented to share holders and users of such statements. The essence of the auditor certifying the financial statements and expressing his professional opinion is to assure the members of the companies that their resources have been judiciously utilized. Also, other users of the financial statements can rely on the professional opinion of the auditor to make certain decisions. Such decisions may include; investment decision, financial decision and any other decisions that may involve their interrelationship with the companies. The professional bodies {e.g. The Institute of Chartered Accountants of Nigeria (ICAN)} have issued guidelines that these auditors are expected to comply with in the process of executing their job. This is to ensure that they meet the expectations of users of such financial statements.

However, with the news of recent corporate scandals around the globe and the subsequent collapse of some of these organizations, one is tempted to ask whether such financial statements were not audited in the first place. Although, auditors claim that it is not their responsibility to detect fraud but rather to express an opinion as to the true and fair view of the financial statement. In response to such statements, can a financial statement prepared to conceal fraud show a true and fair view? This paper therefore seeks to explore fraud and creative accounting as a twin challenge to users of financial statements. The effect of this twin challenge will be highlighted and the role of the auditor in curbing this challenge will also be discussed.

Izedonmi (2000:156); defines fraud as “The intentional misrepresentation of financial information”. Nwaze (2008); is of the view that
fraud relates to a false representation of fact made with the knowledge of its falsity or without belief in its truth, or recklessly careless whether it be true or false. Fraud may include falsification of records and documents, misrepresentation of assets, omission of transactions from records, recording of transactions without substance and misapplication of accounting policies (Izedonmi, 2000). Police (2005) sees fraud as a behavior that is deceptive, dishonest, corrupt or unethical. From the different definitions on fraud, it can be said that fraud is an act or behavior geared towards the misrepresentation of financial information. However, Police (2005); is of the view that fraud may not only involve financial misrepresentation but may also include dishonesty in; obtaining property belonging to someone else, applying some one else’s property to one’s own use, causing a detriment to another persons or entity and gaining a benefit or advantage for any person.

Fraud can occur as a result of so many factors. Police (2005) is of the view that for fraud to exist there needs to be an offender, a victim and an absence of control or safeguard. Okoye and Okafor (2004); citing Cressey (1953), links the cause of fraud to the “fraud Triangle”. The three elements of the fraud triangle are pressure or motive – opportunity- rationalization. Generally, fraud occurs when someone with a financial need (motive) gains improper access to fund (opportunity) and is able to justify the act to themselves or others (Rationalization). This simply means that people commit fraud because they think they need the money, believe they will not be caught and have justified the act to themselves. Izedonmi (2000); links the cause of fraud to weakness in the internal control system of the organization. Accordingly, certain factors will exist within the system that will influence the existence of fraud. Some of these factors are;

- Where authority is concentrated in a few hands within the organization;
- Where management continually fails to implement the internal control recommendations made by the external auditor;
- Where there is high rate of turnover in key accounting functions;
- Where there are frequent changes in the external auditors of the enterprises.
- Where fees paid to legal advisers appears to be out of proportion with the actual services rendered.
- Where the accounting system is inadequate and the books of account cannot be reconciled with the financial statements.
- Where documentations supporting transactions are generally non-existent.
- Where it is difficult to obtain explanations from management and staff of the enterprises during the audit.
- Where the enterprise is experiencing solvency problems.
- Where there are material transactions during or around the year end date.
- Where there are significant transactions with related parties.
Fraud And Creative Accounting: A Twin Challenge To Users Of Financial Information

- Where transactions occurring during the year are reversed after the year end.

Jeff (2009) is of the opinion that “fear and greed” are the main causes of fraud. Nwaze (2008); citing the work of Impey and Variables; relates the cause of fraud to the acronym COMAS.

Concealment: The chance of remaining undetected opportunity.

Opportunity: The right place and right time for the fraudster.

Motivation: A personal need or greed.

Attraction: A desirable target.

Success: The chance of avoiding prosecution.

Fraud occurs in different sectors of the economy. However, researchers (e.g Nwaze, 2008); is of the opinion that fraud in the financial sector (e.g. Banks) is on the increase. This may be due to certain factors which he highlighted below:

i. As a result of the instability and the grim struggle for survival by some banks, marketing and deposit mobilization have been placed conspicuously on the front burner at the expense of controls.

ii. There is an increasing army of experienced bankers being thrown into the already saturated employment market but who are determined to continue to make a living from the banking system even from outside.

iii. There is scanty information about fraudsters and their various syndicates including staff collaborators who are still keeping their jobs while continuing to pollute and subvert the system.

iv. Contemporary issues of consolidation, capitalization, right sizing, rationalization, re-engineering etc. all combine to heighten tension and insecurity in the banking industry.

Accordingly, this may constitute a great temptation for honest staff to look for the non-existent pension and gratuity by settling themselves if the opportunity presents itself.

Furthermore, the statistics of fraud in the Banking sector collated by the Financial Institutions Training Centre (FITC) reveals that the incidence of fraud seems to be on the increase within the financial sector. This can be seen as shown in the tables below;

Table I. (Before Bank Consolidation – 2005).

<table>
<thead>
<tr>
<th>Quarter 2005 Yardstick</th>
<th>1st Quarter Jan-March</th>
<th>2nd Quarter April-June</th>
<th>3rd Quarter July-Sept.</th>
<th>4th Quarter Oct.-Dec.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Amount Involved</td>
<td>1,152,248,997</td>
<td>1,466,910,383</td>
<td>2,258,224,681</td>
<td>2,878,039,083</td>
</tr>
<tr>
<td>Actual/Expected Loss.</td>
<td>260,127,499</td>
<td>369,313,757</td>
<td>522,324,919</td>
<td>1,155,652,438</td>
</tr>
</tbody>
</table>

Table II (After The Bank Consolidation)
Returns of Insured Bank on Fraud and Forgeries

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Year</th>
<th>Total No. Of Fraud Cases</th>
<th>Total Amount Involved (₦' M)</th>
<th>Total Expected Loss (₦'m)</th>
<th>Proportion Of Expected Loss To Amount Involved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;ST&lt;/sup&gt;</td>
<td>2007</td>
<td>397</td>
<td>4, 128</td>
<td>858</td>
<td>20.78</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>268</td>
<td>740.12</td>
<td>422.94</td>
<td>57.14</td>
</tr>
<tr>
<td>2&lt;sup&gt;ND&lt;/sup&gt;</td>
<td>2007</td>
<td>335</td>
<td>1, 083.94</td>
<td>562.53</td>
<td>51.89</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>284</td>
<td>1, 429.06</td>
<td>824.17</td>
<td>57.67</td>
</tr>
<tr>
<td>3&lt;sup&gt;RD&lt;/sup&gt;</td>
<td>2007</td>
<td>398</td>
<td>2,196.0</td>
<td>615.6</td>
<td>28.03</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>334</td>
<td>843.82</td>
<td>547.86</td>
<td>64.94</td>
</tr>
<tr>
<td>4&lt;sup&gt;TH&lt;/sup&gt;</td>
<td>2007</td>
<td>423</td>
<td>2,597.87</td>
<td>834.72</td>
<td>32.13</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>307</td>
<td>1, 819.35</td>
<td>973.69</td>
<td>53.52</td>
</tr>
<tr>
<td>AVERAGE/TOTAL</td>
<td>2007</td>
<td>1,553</td>
<td>10,005.81</td>
<td>2,870.85</td>
<td>28.69</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>1,193</td>
<td>4, 832.17</td>
<td>2,768.67</td>
<td>57.29</td>
</tr>
</tbody>
</table>

Source: NDIC 2007 Annual Report

A look at table II, comparatively between 2006 and 2007 reveals that the cases of fraud are on the increase even after the bank consolidations.

If the statistics provided above is true, one is left to wonder why these fraud cases are not reported in their financial statement so that it can reflect a true view of what transpired within the accounting year. Nwaze (2008); provides the answers and they include;

- Fraud is bad news which would also generate bad image and negative publicity;
- Some of the frauds are serious enough to make regulatory authorities wield the big stick against them;
- Many of the frauds are perpetrated by staff who are related to existing big time depositors or people within the corridors of power;

Unfortunately, this state of affairs does not do anybody any good as a cardinal objective of the reporting principle which is information sharing is not being achieved. Even on the few cases being reported, the actual details are so scanty that not much is gained from it by way of preventive intelligence (Nwaze, 2008).

Creative Accounting

The term “creative Accounting” had been defined variously. Creative accounting is the manipulation of financial numbers usually within the law and accounting standards but very much against their spirit and certainly not providing the true and fair view of a company that accounts are supposed to (www.monyterms.co.uk). Oriol, Blake and Dowds (1999); is of the view that creative accounting involves the process whereby accountants use their...
knowledge of accounting rules to manipulate the figures reported in the accounts of a business.

Abiola and Adebimpe (2002); Links creative accounting with fraudulent accounting, Citing trade way commission (1999); they are of the view that creative accounting involves intentional or reckless conduct that results in materially misleading financial statements.

From the above definitions, creative Accounting can be seen as a fraudulent act aimed at deceiving users of financial statements. Abiola and Adebimpe (2002); gives the characteristics of creative accounting to include;

(a) Manipulation, falsification or alteration of accounting records or supporting documents.
(b) Misrepresentation in or international omission from, the financial statements of events transactions or other information.
(c) Misapplication of accounting principles relating to amounts, classifications, timing, presentation or disclosure.

This could be as a result of internal environment, such as poor systems of internal control and management ignorance or poor attitude (Abiola & Adebimpe, 2002).

**Reasons for Creative Accounting**

Abiola and Adebimpe (2002); are of the view that companies engage in creative accounting because of the expected rewards. These rewards may include a favourable effect on share prices, lower corporate borrowing costs due to an improved credit rating; incentive compensation plans for corporate officers and key employees and for political gains.

Okoye and Alao (2008); in discussing extensively on creative accounting gives the following reasons why companies engage in creative accounting.

1. **Income Smoothing:** Companies generally prefer reporting a steady profit growth trend to volatile profit state. They achieve this by making undue high provisions for liabilities and against asset values in good years so that these provisions can be reduced, thereby improving reported profits in bad years. The argument is that this is a measure against the “shorttermism” of judging an investment on the basis of the yields achieved in the short term. It also avoids raising expectations so high in good years that the company is unable to deliver what is required subsequently. Income smoothing may conceal long term changes in the profit trend.

2. **Income-Boosting:** Company directors may keep an income-boosting accounting policy change in hand to distract attention from unwelcome news. Companies can also manipulate profit to tie into forecasts. This can be achieved when reported earnings are reported to match profit forecasts within the normal accounting rules.
3. **Boosting of Share Price:** Creative accounting may help maintain or boost a company’s share price by reducing the apparent levels of borrowing. This makes the company less susceptible to risk and by creating the appearance of a good profit trend.

4. **To Cover Insider Dealings:** when directors engage in insiders dealing in their company’s shares, they can use creative accounting to delay the release of information. This will enhance their opportunity to benefit from inside knowledge.

5. **Obligations:** Another reason for creative accounting arises because companies are subject to various forms of contractual rights, obligations and constrains based on the amounts reported in the accounts.

**Techniques of Creative Accounting**

According to Okoye and Alao (2008:48); “The potential for creative accounting can be found in six principal areas: Regulatory flexibility, Absence of regulation, Managerial judgment of assumption about the future, Timing of transactions and Reclassification of financial numbers”.

**Regulatory Flexibility:** Accounting regulatory often permits a choice of policy, for example, in respect of asset valuation. The international accounting standard permits a choice between carrying non-current assets at either revalued amounts or depreciated historical cost. Business entities may change their accounting policies but such changes may be relatively easy to identify in the year of change but are much less readily discernible thereafter.

**Absence of Regulation:** Some areas are not fully regulated. For example, there are very few mandatory requirements in respect of accounting for stock options.

**Management Judgment:** Management has considerable scope for estimation in discretionary areas. Genuine transactions can also be timed so as to give the desired impression in the accounts. For example; suppose a business has an investment at historic cost which can be sold for a higher sales price, being the current value. The managers of the business are free to choose in which year they sell the investment to increase the profit in the accounts.

**Artificial Transactions:** This can occur both to manipulate balance sheet accounts and move profits between accounting periods. This is achieved by entering into two or more related transactions with an obliging third party, normally a bank. For example suppose an arrangement is made to sell an asset to a bank and then lease that asset back for the rest of its useful life. The sales price under such a sale and lease back can be pitched above or below the current value of the asset because the difference can be compensated for by increased or reduced rentals.
**Balance Sheet Manipulation:** Firms may engage in balance sheet manipulation to reclassify liabilities in order to smooth reported liquidity and leverage ratios. A special type of creative accounting relates to the presentation of financial numbers based on cognitive reference points.

**Effect of fraud and Creative Accounting on Users of Financial Information**

The users of financial information are many. Porwal (2006); classifies them into Direct and Indirect users:

**Direct Users:** These include owners, creditors, suppliers, potential owners, management, tax authorities, employees and consumers.

**Indirect Users:** These include; financial analyst, stock exchanges, lawyers, regulatory and registration authorities, financial press and reporting agencies, trade association and labour unions.

Porwal (2006); also cites some reasons why users of financial information would need such information:

The reasons are as follows;

i. To be able to decide when to buy, hold or sell an equity investment;

ii. To assess the stewardship or accountability of management

iii. To assess the ability of the enterprise to pay and provide other benefits to its employees;

iv. To assess security for the amount lent to the enterprise;

v. To determine taxation policies;

vi. To determine distributable profits and dividends;

vii. To regulate the activities of the enterprise;

In a study conducted by Abiola and Adebimpe (2002); on the impact of Creative Accounting on investors behaviour, they discovered that;

- Many users of financial information are aware of Creative Accounting and fraudulent reporting in Nigeria;
- Creative Accounting and fraudulent financial reporting impact negatively on investment behaviour amongst the working class group.

The implication of these findings may not be too healthy for the Accounting profession. This is due to the fact that accounting as an information science ought to bridge the gap between the management of the organizations and users of such financial statements. When accounts are prepared and reported to reflect a true and fair view, one is left to wonder what constitute the "trueness" of such financial statement when frauds that took place within the financial year are not reported. Also can a financial statement be said to be of “fair view” when it is discovered that such accounts only reflect a deceptive statement to entice users of such financial statement?

Recently in Nigeria, Cadbury Nigeria plc sacked its managing Director; Mr. Bunmi Oni and Mr. Ayo Akadiri, the financial Director. This is due to the
manipulation of the company's financial records, book padding scandal and corruption. Upon investigation, it was discovered that the company’s financial position has been deliberately overstated over a number of years to the tune of between N13 and N15 billion. Cadbury Nigeria plc had to adjust its accounts to reflect an operating loss between N1 and N2 billion (Okoye and Alao, 2008). Within these years of “surplus” reporting by Cadbury Nigeria plc, were the accounts not audited? Certainly they were and they reflected a “true and fair view”. The cases of Enron, WorldCom and others yet to be discovered are proof that the cases of fraud not reported in financial statement and the issue of Creative Accounting is becoming a big challenge to users of financial information. The auditors are supposed to be “Watch dogs”. Although they claim it is not their responsibility to detect fraud, but they are expected to prepare their audit programs with the assumption that there is fraud within the organization unless proven otherwise.

Furthermore, with the recent corporate scandals around the globe, members of the Accounting profession who serve as auditors should know that the dignity and integrity of the profession is at stake. If users of certified financial statements can no longer rely on them for their decisions, what will they look up to?

Conclusion

It is a known fact that users of financial information will continue to depend on the financial statements produced by companies for their decision making. This therefore implies that; the auditors and accountants empowered by the law to ascertain these financial statements should rise up to the challenge and refuse to drag the image of the profession on the mud. The law and code of conduct have already made provisions for their protection. Users of financial information are waiting for the era when they can fully rely on audited financial information for their decision making as it was some years back.

Recommendations

If the integrity of the accounting profession is to remain, a lot should be done. Based on this, the following recommendations may become useful.

i. The concept of “true and fair view’ should be reviewed by professional bodies and regulatory agencies.

ii. There should be a review of some standards that provide loopholes for creative accounting.

iii. Organizations should be required to disclose fraud when they occur in their financial statement.

iv. Regulatory Agencies should be adequately funded to meet up with their responsibilities.

v. Auditors and reporting accountants should carry out their assignment with due diligence.

vi. There should be rotation of auditors engaged in auditing companies.
References


IMPROVING THE EFFICIENCY OF ELECTRONIC COMMUNICATION SYSTEMS AT MICROWAVE FREQUENCIES

Engr. Barth N. Chiwetalu

Abstract

At microwave frequencies (0.3 –300 GHz), passive circuit components exhibit undesirable effects such as unpredictable behavior and excessive loss of energy by radiation. All these tend to lower the overall efficiency of electronic communication systems. The paper introduces the microwaves; various forms of electrical communication systems; and the various channels or media that can be used in these form of electronic communication systems. The paper discusses measures for improving microwave frequency performance of electronic communication systems through the use of microwave waveguides and its associated components; and microwave circuits in the design of the various subunits of electronic communication systems. In order to utilize the gains of large scale integration of ICs, the paper concludes by recommending the use of Microwave Integrated Circuits (MICs) in checkmating the shortcomings of electronic communication systems at such higher frequencies.

Introduction

Microwaves are electromagnetic radiations of frequencies, generally between 0.3 –300 GHz, with wavelength ranging from 0.3 – 30cm. This wavelength is found between infrared and short wave radio wavelengths (Stephen, 1997). Microwave frequency signals have found applications in areas other than those in communication and in radar uses, they are also used in medicine, surveying lands, heating, industrial quality control etc (Simon, 1988). They are propagated in straight line (ie line-of-sight propagation) and are affected very little by the troposphere but refracted or reflected by ionized regions in the upper atmosphere. Microwave beams do not readily diffract around barriers such as hills, and large human-made structures. However, attenuation occurs when microwave energy passes through trees and houses (www.search networking techtarget.com).

Electronic communication is any transmission and reception of signals (which include stand, pictures, etc) through wire or electromagnetic system at any given frequency (www.wikipedia.com). Jeffrey (2005) noted that the objective of the application of microwave frequencies is to develop commutation networks with maximum efficiency of signals transmitted at a given range with less distortion due to environmental conditions. Consistent with the foregoing, Bruno (1998) stated that the point-to-point signal transmission of a communication network is most appropriate and environmental friendly since it dose not cause hazard when microwave frequency waves are used. The quality of a nation’s communication network determines how fast and reliable the message transmitted gets to the expected destination, which in turn determines her level of...
technological development (Dunlope, 1994). The realization of the foregoing gains of microwave frequency signal transmission depends to a very great extent on the forms of electronic communication system, which can be radio telephony and telegraphy, broadcasting, point – to – point mobile communication, computer communication, etc (Okeket, 2000).

These forms of electronic communication systems use different types of channels and media to accomplish the task of information transmission (Ekemezie & Ngene, 2004). The various types of channels include:

–Twisted-pair wire: This consists of two strands of insulated copper wire, twisted around each other. Twisted pair wire has been the most common channel or medium used for telephone systems. This telephone line which has been the standard transmission medium for years but is gradually being phased out by more technically enhanced and reliable media. It is relatively cheap but slow and does not protect well against electrical interference.

–Coaxial cables: These are another type cabling scheme that is often used for data communication (video and voice transmission) is coaxial cable. It is made up of insulated copper wire wrapped in a solid or braided metal shield, and then in an external cover. Coaxial cable is much better than twisted-pair wire and transmit high frequencies, allowing for high data rates, and is less susceptible to noise than the twisted pair wire.

–Fiber-Optic cables: They consist of dozens or hundreds of thin strands of glass or plastic that transmit pulsating beams of light rather than electricity. These strands can transmit up to two billion pulses per second. When bundled together, fibre-optic strands in a cable 0.12 inch thick can support a quarter-million to half-million voice conversations at the same time. Moreover, unlike electrical signals, light pulses are not affected by random electromagnetic interference in the environment. Thus they have much lower error rates that normal telephone wire and cable. In addition, fibr-optic cable is light, more reliable and more durable than twisted-pair and co-axial cables. A final advantage is that it cannot easily be wire trapped, so transmission are more secure. It is however more expensive and transmits better at limited distances.

Infrared wireless Transmission: This is the transmission of data signals using infrared-light waves. Infrared ports can be found on some laptop computers and printers, as well as wireless mouse. The advantage is that no physical connection is required among devices. The drawback is that a line of sight communication is required i.e. there must be an unobstructed view between transmitter and receiver. This restricts transmission to short range.

Broadcast Radio: This is a wireless transmission medium that sends data over long distances-between regions, states, or countries. A transmitter is required to send messages and a receiver to receiver them; sometimes both sending receiving functions are combined in a transceiver. In the lower frequencies of the radio spectrum, several broadcast radio bands are reserved not only for conventional AM/FM radio but also for broadcast television CB (citizens band) radio, cellular phones, and private radio land mobile services.
Microwave Radio: Transmission of voice and data through the atmosphere as super high frequency radio waves is by microwaves. These frequency are used to transmit messages between ground-based stations and satellite communications system. Microwaves are line of sight i.e they cannot bend around corners or around the earth’s curvature. Microwave stations need to be placed between transmitter and receiver to transmit over long distances. A microwave relay station receives in coming signal, boosts the signal strength, and relays the signal to the next station. Nowadays, microwave reflective dishes, which contain transceivers and antennas, are nearly everywhere.

Communication satellites: These are microwave relay stations that orbit the earth, occupying either low medium, or high (geostationary) earth orbits.

The highest level, known as geostationary earth orbit (GEO), is 22,300 miles up and directly above the equator. Because the satellites in this orbit travel at the same speed as the earth, they appear to an observer on the ground to be stationary in space – that is, they are geostationary. Consequently, microwave earth stations are always able to beam signals to fixed location above.

In the present times, electronic communication systems have to face technological challenges in terms of improved information transmission channels reliability, energy conservation etc.

Therefore, the main thrust of the paper is to make the different forms of electronic communication systems amenable for use at microwave frequencies. This condition would enable an increase in these indices of efficiency of electronic communication system.

Measures for Making Forms of Electronic Communication Systems Amenable for Microwave Signals

Use of microwave waveguides and associated components

Waveguides are hollow metallic pipes, which may have either circular or rectangular cross sections, used for carrying electromagnetic waves at microwave frequencies. This waveguide serves the same purpose as transmission lines used at lower frequencies. The internal walls of waveguide are not mirrored surface, but rather electrical conductors. These internal walls are electroplated with either gold or silver so as to reduce ohmic losses. Waveguides are preferred to transmission lines because they are less lossy at highest frequencies; propagate signals in different modes; the power handling ability is higher than in the coaxial air-dielectric rigid cables; lower power losses than in comparable transmission line (Kennedy & Davis 1993).

Also cavity resonators evolve from waveguides. This is a piece of waveguide closed off at both ends with metallic planes. Microwaves propagating in the longitudinal direction in the resonator results in the existence of standing wave and oscillations can take place in the waveguide if the resonator is suitable excited.

Cavity resonators are employed for much the same purposes as tuned LC circuits or resonant transmission lines, but naturally at much higher frequencies since they have the same overall frequency coverage as waveguides. They may
be input or output tuned circuits of amplifiers, tuned circuits of oscillators, or resonant circuits used for filtering or in conjunction with mixers. In addition, they can be shaped to be an integral parts of microwave amplifying and oscillating devices. The cavity resonator can be used as a cavity wave meter, used in microwave frequency – measuring (Joseph, 1997).

Basically, the simple cavity is cylindrical in shape, usually with a plunger whose insertion varies the resonant frequency. Adjustment is by means of a calibrated micrometer. The plunger has absorbent material on one side of it (the back) to prevent oscillations in the back cavity, and the micrometer is calibrated directly in terms of wavelength, from which frequency may be calculated.

A signal is fed to a cavity wavemeter through an input loop, and a detector is connected to it through an output loop. The size of the cavity is adjusted with the plunger until the detector indicates that pronounced oscillations are taking place, whereupon frequency or wavelength is read from the micrometer.

Since cavity resonators are similar to tuned circuits and tuned circuits cannot be used in practice unless it is possible to couple energy to them or from them; and are not of much practical use unless they are tunable, them cavity resonators must undergo coupling and tuning. Coupling to cavities uses same methods as are employed with waveguides. Thus, various slots, loops and probes are used to good advantage when coupling of power into or out of a cavity is desired, realizing however, that taking an output from a cavity not only loads it but also changes its resonant frequency slightly.

On the other hand, tuning of cavities uses same methods as were used for impedance matching of waveguides, using adjustable screws, or posts. However it is important to examine the effects of such tuning, and also loading, on the bandwidth and Q of the cavity resonator Q has the same meaning for cavity resonators for any other tuned circuits and may be defined as the ratio of the resonant frequency to the bandwidth. However, it is perhaps more useful to base the definition of Q here on a more fundamental relation, thus:

\[ Q = \frac{2\pi}{\text{Energy Stored}} / \text{Energy lost each cycle} \]

When a cavity is tuned by means of a screw or sliding piston, its Q will suffer, and this should be taken into account. Q decreases because of the extra area due to the presence of the tuning elements, in which current can flow, but this state of affairs is not always undesirable because wideband applications exist in the microwave range also.

Other auxiliary microwave components that help to ensure efficiency of electronic communication systems include directional couplers, isolators, circulators, mixers, detectors and switches.
Use of Microwave Solid-State Devices & Circuits

Researches in this segment of microwave field have resulted in a tremendous proliferation of, and improvement in, semiconductor devices for microwave amplification, oscillation, switching, limiting, frequency multiplication and other functions. For the electronic communications systems designers, the result of these continuing improvements has been greater flexibility, improved performance, greater reliability, reduced sizes and power requirements, and importantly the ability to produce some systems that would not otherwise have been possible (Kennedy & Davis, 1993).

The specific ways these microwave solid-state devices (e.g. silicon bipolar transistor, GaAsFET); microwave integrated circuits (e.g. hybrid MICs, monolithic MICs); and microwave passive circuits (e.g. stripline, microstrip, SAW devices) are employed in enhancing the performance of electronic communication systems are seen in the use of stripling or microstrip in the packaging of semiconductor microwave devices, and use SAW devices in the low microwave range. Again the microwave transistor (GaAsFET) is seen to have lower noise figure, and yield noticeably higher powers. Furthermore the microwave integrated circuits (GaAsFET monolithic MIC) is a high-gain four-stage power amplifier developed for satellite communications. Microwave power transistors serve as output stages in microwave links, driver amplifiers in wide range of high-power transmitters (including radar ones), and as output stages in broadband generators and phase array radars.

Other microwave semiconductor devices that contribute in increasing the efficiency of electronic communication systems through their various applications in the microwave range are the microwave diodes. For example, the tunnel diode amplifiers may be used throughout the microwave range as moderate-to-low noise preamplifiers in all kinds of receivers; as self-excited mixers; and in high-speed switching and logic operations as in flip-flop and gates. Tunnel diode can be used as low-power oscillators up to about 100GHz, because of their simplicity, frequency stability and immunity to radiations. Also Gunn diode oscillators are employed frequency as low- and medium-power oscillators in microwave receivers and instruments. For example/parametric amplifiers now use Gunn diodes as pump sources due to their much lower noise. The higher-power Gunn diode oscillators are used as power output oscillators in wide variety of low-power transmitter applications as in police radar, burglar alarms and aircraft rate-of-climb indicators.

The varactor diode can be used as capacitors in microwave circuits. Because it is a variable capacitor, it can be used in most applications where an ordinary mechanical capacitor of same value might be used. Varactors are used to tune variable LC resonant tank circuit. In fact, the receiver automatic frequency control (AFC) can use a varactor diode to pull the local oscillator (LO) signal to the correct point under command of an error signal generated by the detector. Also the AFC circuits are commonplace in FM receivers. Again, varactor are used in tuning of the voltage-controlled oscillator in a phase-locked-loop synthesizer; and in frequency modulation. Recall that piezoelectric crystals
are generally used in transmitters to set operating frequency. The frequency of oscillation for these crystals is a function of circuit capacitance, so by connecting a varactor either in series or parallel with the crystal, we can cause its frequency to change with changes in applied voltage. Thus, the audio or analogue telemetry signal voltage can frequency-modulate the crystal oscillator.

**Conclusion**

It has been be shown that different forms of electronic communication systems respond to microwave signal when the various sub-units used in each form of electronic communication system were realized with microwave comports and circuits. The advantages of microwave communication thus utilized by these forms of electronic communication systems were explained, to be responsible for their higher efficiency performance. Specific measures to ensure efficient high-frequency performance using waveguides and auxiliary waveguide components such as cavity resonators, directional couplers, isolators etc were explained.

Also, the use of microwave integrated currants (e.g GaAsFET monolithic MIC) which has resulted in a tremendous enhancement of the efficiency of electronic communication systems was shown. In view of the impact of microwave integrated circuits on the improvement of efficiency of electronic communication system, I recommend that more researches be devoted to this segment of microwave field so as to ensure a greater use of MICs in enhancing the efficiency of communications systems.

**References**


