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Contents

Increasing Incidence of Upper Urinary Tract Calculi in a Nigeria Teaching Hospital

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Abstract

Upper urinary tract calculi are generally believed to be rare in the African Continent especially in Nigeria. Recently, however, there appears to be an increasing trend in the incidence of upper urinary tract calculi which appears to be the trend globally

The increasing prevalence probably reflects a change in lifestyle especially dietary and widespread availability of diagnostic facilities especially ultrasonography.

We present a retrospective study spanning 3 years (2003-2005) in a Teaching Hospital in Nigeria. 55 cases of upper urinary tract calculi were seen during the period, contrasting with less than 10 seen in the previous decade in the same Hospital. There was a trend towards smaller stones and upper tract stones compared to the previous decade when 80% of the stones were in the urinary bladder

Unfortunately, our study was limited by unavailability of facilities to analyze the stones and classify them. This limits the epidemiologic characterization of the stones and prevents the identification of potential etiological factors.

Endo-urology facilities and shock wave therapy were not readily available in Nigeria causing a number of the patients to have open procedures.

With the increasing incidence of urolithiasis, there is an urgent need for Government and Private Institutions to invest in facilities that will aid the diagnosis, characterization and treatment of the stones.

Key words: upper urinary tract calculi, ultrasonography

Introduction

Urolithiasis research in Nigeria and indeed Africa has not being extensively studied as a result of limited facilities for diagnosis, analysis and treatment.

Upper urinary tract calculi are generally believed to be rare in the African Continent especially in Nigeria.[1-3] Recently; however, there appears to be an increasing trend in the incidence of upper urinary tract calculi which appears to be the trend globally. [4-7]

Indeed, in the whole West African sub-region consisting of over 16 countries and a population of over 250 million, there is no centre for infrared spectroscopy and morphologic analysis of stones and less than 5 canters have facilities for extracorporeal shock wave lithotripsy.

A review of the Medline articles on urolithiasis showed that less than 200 papers have been published from Africa contrasting with over 24000 in other continents

While the dearth of information on the subject may be due to the rarity of the disease, it is also possible that with availability of facilities for diagnosis and treatment, more cases will become apparent.

Materials and Methods

This was a retrospective study carried out at Abia State University Teaching Hospital located in the South-eastern part of Nigeria. The study period was three years (January 2002 to January 2005)

Information was extracted from the records of patients seen at our Urology Clinic for Upper Urinary Tract Calculi. The bio-data, clinical presentation, ultrasound findings, urinary culture, and treatment were analyzed.

The objective of the study was to show the pattern of presentation of upper urinary tract stone, and to compare our study with the record of urinary tract stone seen in the same centre in the previous decade.

Results

A total of 55 cases of Upper Urinary Tract Stones were seen during the study period of 2003-2005 and only 26 were suitable for the purpose of the study. In the previous decade 1993-2003, only 10 cases of Urolithiasis were seen and 80% were bladder stones.

There were 22 males and 4 females, M: F incidence was 5.5:1. Age range was 21-70 with the peak incidence in the 4th decade.

77% of the stones were in the kidney, 15% in the renal pelvis and 8% in the ureter.

It was unilateral in 79.8% of cases and bilateral in 19.2% of cases.

88 %(23) presented with loin pains and only two patients presented with hematuria (Incidentally, these two patients had ureteric stones)

53% (14) of the stones were solitary while 47%(12) were multiple. 20% of the stones were bigger than 2cm in diameter whilst the remaining 80% were smaller than 2cm.

Discussions

The findings of this study shows
1. Increasing incidence of upper urinary tract stones in our centre
2. A change in trend from lower urinary tract stones to upper urinary tract stones
3. A change from big sized stones (> 2cm) to smaller sized stones

These findings raise a lot of interesting questions. Is the rise in prevalence apparent or real? In the past decade, majority of the centers in Nigeria including ours lack facilities for diagnosis especially ultrasonography. Most of the diagnoses then were made by clinical assessment and plain abdominal radiographs. As only 90% of urinary tract stones are radio-opaque[8], the remaining 10% go undiagnosed by this assessment.

Ultrasonography is not only sensitive but can pick the stone when it is very small in size.

With widespread availability of ultrasonography facilities and skilled personnel to use them, it is possible that more stones which remained undetectable in the previous decades are now becoming apparent.

It will be interesting to do a survey of the healthy population using ultrasound to identify the true prevalence of renal stones in our community.

There is however, a global increase in prevalence and incidence of renal stones [9-13]. This has been attributed to lifestyle changes, diet and improved medical care. Increased urbanization and industrialization has impacted on the lifestyle of the average Nigerian with a change from the typical bulky vegetarian diet to Western Diet.

Most cities in Nigeria now have fast food centers where most people patronize; there is also increased consumption of soft drinks and sachet water. A proper analysis of the chemical contents of these drinks will be very helpful in identifying the risk factors.

The change in trend from lower urinary tract stones to upper tract stones is also a reflection of lifestyle changes. Lower urinary tract stones especially in the pediatric age group have been attributed to malnutrition and infection. With the rising standard of living in Nigeria and education, malnutrition is gradually fading out.

The trend of seeing smaller sized stones compared to bigger stones may also be markers of new stone formation in the population and improved diagnostic methods.

The fact that all the patients treated in this study had open procedures underscores the need to invest in minimally invasive facilities with less morbidity and mortality.

The rise in smaller sized stones also means that open procedures will become more dangerous and risky for the patients.

Lack of facilities for characterizing and analyzing the stones also means that a proper epidemiologic analysis of urolithiasis is a mirage and if the rise in incidence is sustained, we are losing the opportunity to identify the risk factors and educate our people.

A further prospective multi-centre study will be necessary to confirm the true position of urolithiasis in Nigeria.

References

[1]   Esho J (1978) The rarity of urinary calculus in Nigeria. Trop Geogr Med 30:86
[2]   Esho J (1978) Analysis of urinary calculi formed by Nigerians. Eur Urol 4:288
[3]   Mbonu O, Attah C, Ikeakor I. Urolithiasis in an African population. Int Urol Nephrol 1984 ; 16(4):291-6.
[4]   Olapade-Olaopa E, Agunloye A, Ogunlana D, Owoaje E, Marinho T (2004) Chronic dehydration and syptomatic upper urinary tract stones in young adults in Ibadan, Nigeria. West Afr J Med 23:146
[5]   Mshelia DS, Gali BM, Naaya UH, Habu SA. Chemical composition of urinary calculi in Maiduguri, Nigeria. Afr J Med Med Sci. 2005 Jun;34(2):185-8.
[6]   Stamatelou KK, Francis ME, Jones CA, Nyberg LM, Curhan GC (2003) Time trends in reported prevalence of kidney stones in the United States: 1976–1994. Kidney Int 63:1817–1823.
[7]   Hesse A, Brandle E, Wilbert D, Kohrmann KU, Alken P (2003) Study on the prevalence and incidence of urolithiasis in Germany comparing the years 1979 vs. 2000. Eur Urol 44:709– 713
[8]   Gillenwater, Jay Y.; Grayhack, John T.; Howards, Stuart S.; Mitchell, Michael E. Adult and Pediatric Urology, 4th ed. Lippincott Williams & Wilkins, Philadelphia,2002.
[9]   Johnson CM, Wilson DM O'Fallon WM, et al: Renal stone epidemiology: A 25- year study in Rochester Minnesota. Kidney Int 16:624–631, 1979
[10]   Norlin A, Lindell B: Urolithiasis: Astudy of its frequency. Scand J Urol Nephrol 10:150–153, 1976
[11]   Yoshida O, Okada Y: Epidemiology of urolithiasis in Japan: A chronological and geographical study. Urol Int 45:104–111, 1990
[12]   Serio A, Fraioli A: Epidemiology of nephrolithiasis. Nephron 81 (Suppl 1):26–30, 1999
[13]   Trinchieri A, Coppi F, Montanari E, et al: Increase in the preva- lence of symptomatic upper urinary track stones during the past ten years. Eur Urol 37:23–25, 2000

Tables

Table 1: Age Incidence

Age Range In Years	No of Cases	%
0-10	0	0
11-20	0	0
21-30	5	19.23
31-40	10	34.61
41-50	5	19.23
51-60	5	19.23
61-70	1	3.85
71	1	3.85
TOTAL	26	100

Table 2: Anatomic Site of Stone

Anatomic Site	No	%
Kidney	20	76.9
Renal pelvis	4	15.4
Ureter	2	7.7
TOTAL	26	100

Table 3: Kidney Involved

Kidney Involved	No	%
Rt kidney	14	53.8
Lt kidney	7	26.9
Bilateral	5	19.2
TOTAL	26	100

Table 4: Surgical Procedures Done

Nephrectomy	2
Pyelolithotomy	4
Nephrolithotomy	10
Conservative management and spontaneous resolution	1
Awaiting definitive treatment	9

Table 5: Number of Stones

SOLITARY/SINGLE	14
MULTIPLE	12
TOTAL	26

Incidence per year

1993 – 2003	10
2003	12
2004	18
2005	25
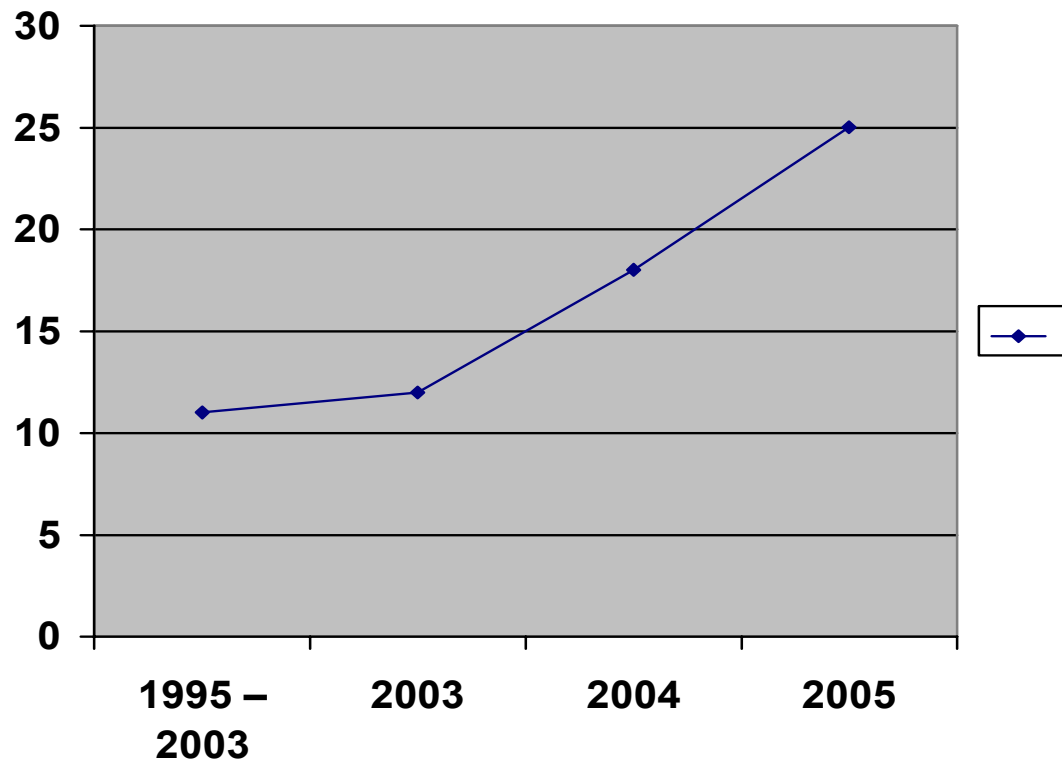
The Forecast Models for Energy Generated, Consumed and Number of Consumers

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Abstract

Energy sector in Pakistan comprises power, gas, petroleum and coal. Although the per capita energy consumption is low in Pakistan, it is nevertheless increasing gradually over the last one decade. Despite having vast potentialities for energy resource, Pakistan remains energy deficient country. The number of consumers has increased due to rapid urbanization, extension of electricity grid supply to un-electrified areas and rural/village electrification. The forecast models have been developed for the generation of energy, the number of consumers, the electricity consumed and the maximum demand of electricity. The best model is selected by comparing, the value of R^2, the standard error of regression, log-likelihood, Akaike information criterion, Schawarz criterion and Durbin-Watson statistic. The estimates of the coefficients in the ARIMA models are checked to ensure that the process is stationary / invertible. Further the mean square error of forecasts are also considered and compared. The final models are, total number of consumers ARIMA(0,1,1), total electricity consumed ARIMA(1,0,0), maximum demand of electricity ARIMA (1,0,0), and total energy generated ARIMA (6,1,4).

1. Introduction

At present, over a billion people in the industrialized countries use some 60 percent of the world's commercial energy supplies, while 5 billion people living in the developing countries consume the remaining. Many of these people live in the developing countries and they are mostly poor. The poor, in particular, need to be provided with a minimum amount of energy at affordable rates. To achieve this goal, the energy needs to be produced and supplied at low cost. In fact, efficient energy use plays an important role in the social and economic development.

Energy sector in Pakistan comprises power, gas, petroleum and coal. Total primary energy supplies measured in terms of tones of oil equivalent (TOE) in 2001-02 were 45.2 million. The oil, natural gas, electricity and coal provide 41.3, 42.9, 11.2 and 4.6 percent, respectively of the total primary energy supplies.

As the energy consumption in Pakistan is very low but it will seem to be increasing in the near future. For this increase we do not have sufficient energy resources so ultimately we will have to face a deficit in energy resources. Due to immense migration of people from rural to urban area, the number of energy consumers has increased. The number of consumers has increased to 13.0 million by March 2003, as compared to 12.7 million in 2001-02.

Among many others Houthakker [1951a], Taylor [1975], Nelson and Stephen Peek [1985], Franklin M. Fisher and Carl Kaysen [1962], Bohi [1981], Daniel McFadden [1984] have done a lot of work in the field of electricity generation, consumption and its demand.

2. Methodology

The data has been collected from Water and Power Development Authority (WAPDA) Lahore from the year 1984 to 2003. Various ARIMA models have been fitted on the number of consumers and energy consumed in the economic groups, energy generated and its maximum demand. The best models are decided which has, the maximum value of R^2, and the minimum values of the standard error of regression, log-likelihood, Akaike information criterion, Schawarz criterion and Durbin-Watson statistic is used to check the auto correlation among error terms. Further the estimates of the coefficients in the ARIMA models are checked to ensure that the process is stationary / invertible and the mean square error of forecast are also considered and compared.

3. Analysis

The number of consumers in the economic group comprising of domestic, commercial, industrial and agricultural Table 1 shows the comparative study of the selected models. After comparing each of the measure used as a criterion for the best model, model no.1 is considered to be the best fitted model on the total number of consumers. The forecast model for the total number of consumers is ARIMA (0,1,1)

$$X_t^C = 485540.0 + 0.843585Z_{t-1}^C \tag{1}$$

Where X_t^C is the number of consumers at time 't' and Z_t^C is the white noise process at time 't'. Figure 1 shows the graph of actual and forecast values together with the residuals for number of consumers.

The best choice for the total electricity consumed is model no. 2 The forecast model is therefore ARIMA (1,0,0)

$$Y_t^T = 100087.2 + 0.825092Y_{t-1}^T \tag{2}$$

Where Y_t^T is the total electricity consumed at time 't'. Figure 2 is the graphic presentation of the actual, forecast and residual values of the best-fitted model on the total electricity consumed.

The study reveals that the best choice for the selected models on the total energy generated is model no. 3. The forecast model is therefore ARIMA(6,1,4)

$$Y_t^G = 2920.742 - 0.942098Y_{t-6}^G - 0.960191Z_{t-4}^G \tag{3}$$

Where Y_t^G is the total energy generated at time 't' and Z_t^G is the white noise process at time 't'. Figure 3 is the graphic presentation of the actual, forecast and residual values of the best fitted model for total energy generated.

The forecast model for maximum demand of electricity is therefore model no. 4 which is ARIMA (1,0,1)

$$Y_t^M = 12857.25 + 0.944103Y_{t-1}^M - 2.017281Z_{t-1}^M \tag{4}$$

Where Y_t^M is the maximum demand at time 't' and Z_t^M is the white noise process at time 't'. Figure 4 is the graphic presentation of the actual, forecast and residual values of the best-fitted model on maximum demand of electricity.

4. Conclusion

Since the generation of energy and its consumption plays a major role in the development of the country, it is tried to develop statistical models to forecast the generation of energy, the number of consumers in the economic group, the consumption of electricity per consumer in the economic group and the maximum demand of electricity.

Various diagnostic tools have been employed for the model adequacy those include the estimates of the coefficients in the ARIMA models to ensure that the process is stationary / invertible, the value of R^2, the S.E. of regression, log-likelihood, AIC, SBC and DW statistic. Further the MSE of forecast errors were also considered and compared.

The forecast models for the total number of consumers is ARIMA(0,1,1), the total electricity consumed is ARIMA (1,0,0), the total energy generated is ARIMA(6,1,4), maximum demand of electricity is ARIMA (1,0,1)

Finally we hope that the fitted models for forecast will be helpful to meet the energy problem in the country. The forecast for the number of consumers, the consumption of energy and the consumption of electricity per consumer will be available and therefore keeping in view the total demand, efforts can be made for the required generation of energy.

References

[1]   Akaike, H. (1969), Fitting auto regressions for predictions, Annals of the Institute of Statistical Mathmetics, Tokyo.

[2]   Akaike, H. (1973), Information theory and an extension of the maximum likelihood principle, 2nd International Symposium on Information Theory, B. N. Petrov and F. Csaki (eds), Akademiai Kiado, Budapest.

[3]   Akaike, H. (1978), Time Series analysis and control through parametric models, Applied Time Series Analysis, D. F. Findley (ed.), Academic Press New York.

[4]   Box, G. E. P. and Jenkins, G. M. (1970), Time Series Analysis: Forecasting and Control, Holden-Day, San Francisco.

[5]   Box, G. E. P. and Pierce, D. A. (1970), Distribution of residual autocorrelations in auto-regressive integrated moving average time series models. J. Amer. Statist. Assoc.

[6]   Economic Survey of Pakistan for the year 2003.

[7]   Fisher, Franklin M. in association with Carl Kaysen (1962), A study in Econometrics : The demand for electricity in United States, Amsterdam; North Holland.

[8]   Friedman, Milton (1957), A theory of Consumption Function. Princeton, Princeton University Press for the National Bureau of Economic Research.

[9]   Houthakker Hendrik S.(1951a), Some calculations of electricity consumption in Great Britain, Journal of the Royal Statistics Society (A), No. 114 part III

[10]   Houthakker Hendrik S (1951b), Electricity Tariffs in theory and practice, Economic journal 61:241

[11]   Nelson, Charles R. and Stephen C.Peek (1985), The NERC Fan: A Retrospective Analysis of NERC summary Forecasts, Journal of the business and economic Statistics, 3:3, July 197-187

[12]   Power System Statistics Twenty eighth issue, Water and Power Development Authority planning department Power Wing February 2004.

Appendix

Figure 1: Graph of Actual and Forecast Values for Number of Consumers Model (1)
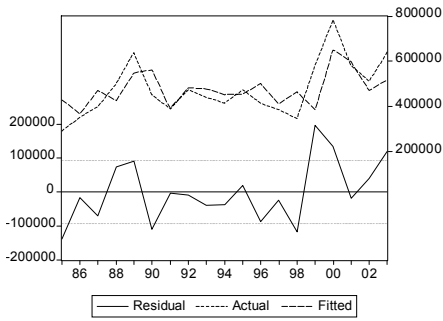
Figure 2: Graph of Actual and Forecast Values for the Total Electricity Consumed for Model (2)
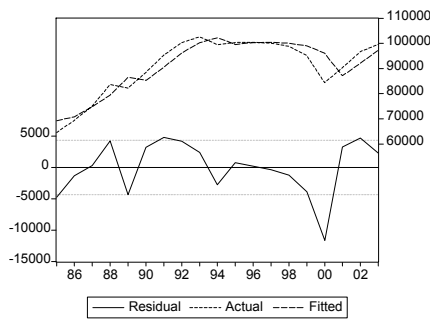
Figure 3: Graph of Actual and Forecast Values for Total Energy Generated for Model (3)
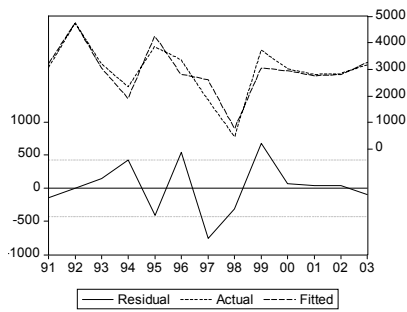
Figure 4: Graph of Actual and Forecast Values for Maximum Demand for Model (4)
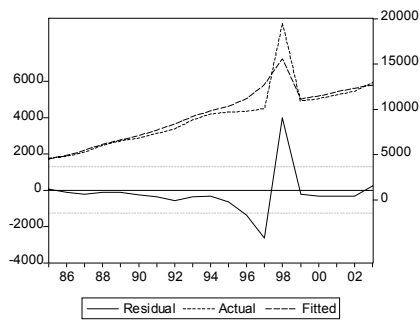
The Effect of Viscous Dissipative Heat and Uniform Magnetic Field on the Free Convective Flow Through a Porous Medium with Heat Generation/Absorption

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Abstract

The paper considers the twin effects of dissipative heat and a uniform externally applied magnetic field on the free convection flow in a porous medium when there is heat absorption/generation over a porous plate. Adopting a perturbative series expansion about a small parameter, ε, and assuming a linear dependence of the flow fields on E_c, expressions are obtained describing the velocity, temperature and skin friction coefficient. The effects of the governing parameters on the flow variables are discussed quantitatively with the aid of graphs for the temperature and velocity, and a table for the skin friction. Our results show that heat generation increases the fluid velocity when free convection currents cool the plate.

Introduction

The study of fluid flow through a porous medium has applications in medicine, science, agriculture and engineering – fluid dynamics. As in Khaled et al [1], we can define a porous medium as a material volume consisting of solid matrix with an interconnected void. It is mainly characterized by its porosity, ratio of the void space to the total volume of medium. Soundalgekar [2] studied free convection effects on the oscillatory flow of an incompressible, electrically conducting, viscous fluid past an infinite vertical porous plate in the presence of constant suction and obtained results that showed that there is a reverse flow of the mean velocity profile of fluids, with small Prandtl number, in the boundary layer close to the plate, which is been heated by free convection currents. Mansour [3] extended the study to include the effects of radiation and free convection on oscillatory flow where the main conclusion was that the mean temperature in the boundary layer increases with increase in radiation. Raptis [4] studied the flow of a micro-polar fluid past a continuously moving plate by the presence of radiation and showed that an increase in radiation parameter leads to a decrease of the temperature. Kim [5] and [6] studied the unsteady MHD flow with variable suction and showed that for a constant plate moving velocity with a given magnetic and permeability parameters, Prandtl and Grashof numbers, the effect of increasing values of suction velocity parameter resulted in slight increase in surface skin friction for lower values of plate moving velocity. Helmy [7] presented a study of an analysis of unsteady two-dimensional laminar free convection flow of an incompressible, viscous, electrically conducting (Newtonian or polar) fluid through a porous medium bounded by an infinite plate surface of constant temperature. Raju {8] and [9] reported the results of an analysis on

the oscillatory two-dimensional flow past an infinite vertical porous plate where it was shown that the transient velocity, for air and water, decreases as the Prandtl number increased. Cookey et al [10] studied the influence of viscous dissipation and radiation on unsteady MHD free-convection flow past an infinite heated vertical plate in a porous medium with time dependent suction, while Chamkha [11] reported the results of a study of unsteady MHD convective heat and mass transfer past a semi-infinite permeable moving plate with generation where it was found that as the solutal Grashoff number Gr (free convection parameter) increased the fluid velocity also increased. Recently, Ibrahim et al. [12] have reported the results of their study of unsteady magneto-hydrodynamic micro-polar fluid flow and heat transfer over a vertical porous plate through a porous medium in the presence of thermal and mass diffusion with constant heat source where they observed among other things that as the magnetic parameter was increased the velocity was seen to decrease.

As shown in Soundalgekar and Hiremath [13] for moderately high plate motion or motion under strong gravitational field, viscous dissipative heat cannot be neglected so in this study we consider the effect of heat generation or absorption on free convective flow through a porous medium in the presence of a uniform magnetic field and viscous dissipative heat. The governing coupled nonlinear partial differential equations are decoupled by expansion about a small parameter ε ($\varepsilon \ll 1$) and then linearized by assuming the resulting parameters are linear functions of E_c, the Eckert number. The linear equations are then integrated.

Mathematical Problem Formulation

The study, see figure 1, considers the two-dimensional flow of a viscous, incompressible, radiating fluid of density ρ and permeability σ^* through a porous medium occupying a semi-infinite region of space bounded by an infinite vertical plate. Figure 1 shows the physical model where the x'-axis is taken along the vertical and the y'-axis along the horizontal perpendicular to the plate. All fluid properties are assumed constant except density variation along the gravitational field and a

Figure 1: The Physical Co-ordinate System
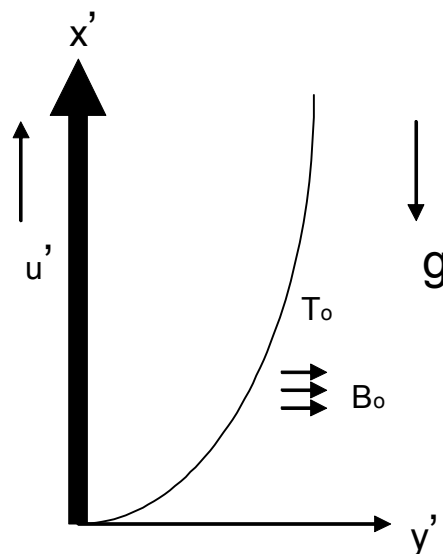
uniform magnetic field B_o , is applied in the y' direction. Therefore the governing equations describing the model proposed in the study are

$$\frac{\partial v'}{\partial y'} = 0 \tag{1}$$

$$\frac{\partial u'}{\partial t'} + v'\frac{\partial u'}{\partial y'} = v\frac{\partial^2 u'}{\partial y'^2} - \frac{v}{k'}u' - \frac{\sigma^* B_o^2}{\rho}u' + g\beta(T'-T'_\infty) \tag{2}$$

$$\frac{\partial T'}{\partial t'} + v'\frac{\partial T'}{\partial y'} = \frac{\kappa}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2} + \frac{v}{c_p}\left(\frac{\partial u'}{\partial y'}\right)^2 + Q \tag{3}$$

In equations (1) to (3), (u',v') are the velocity components along the x'- and y' - directions respectively. β is the coefficient of volume expansion, v is the kinematic coefficient of viscosity, k' is the permeability, t' is dimensional time, κ is thermal conductivity, Q is the heat sink/source and subscript '∞' or 'w' designate conditions in the free stream and at the wall respectively.

From equation (1) we assume

$$v' = -v_0 \tag{4}$$

Combining Eq (4) with Eqs (2) and (3), we have

$$\frac{\partial u'}{\partial t'} - v_o\frac{\partial u'}{\partial y'} = v\frac{\partial^2 u'}{\partial y'^2} - \frac{v}{k'}u' - \frac{\sigma}{\rho}B_o^2 u' + g\beta(T'-T'_\infty) \tag{5}$$

$$\frac{\partial T'}{\partial t'} - v_o\frac{\partial T'}{\partial y'} = \frac{\kappa}{\rho c_p}\frac{\partial^2 T'}{\partial y'^2} + \frac{v}{c_p}\left(\frac{\partial u'}{\partial y'}\right)^2 + Q \tag{6}$$

The boundary conditions now are

$$u' = 0 \qquad T' = T_w \qquad at \quad y' = 0$$
$$u' \to \infty \quad T' \to \infty \qquad as \quad y' \to \infty \tag{7 a, b}$$

We now introduce the following non-dimensional quantities and parameters

$$t' = \frac{t}{\omega} \quad u' = \frac{u}{v_o} \quad y' = \frac{v}{v_o}y \quad \theta = \frac{T'-T'_\infty}{T_w - T_\infty} \quad P_r = \frac{\mu c_p}{\kappa} \quad G_r = \frac{v g \beta}{v_o^3}(T_w - T_\infty)$$

$$E_c = \frac{v_o^2}{c_p(T_w - T_\infty)} \quad k' = \frac{v^2}{v_o^2}K \quad \sigma = \frac{v\omega}{v_o^2} \quad \alpha = \frac{vQ}{v_o^2(T'-T'_\infty)} \quad M = \frac{\sigma B_o^2 v}{v_o^2 \rho} \quad \frac{1}{K} = \frac{v^2}{K'v^2} \tag{8}$$

In virtue of equation (8), equations (5) and (7) now become

$$\frac{\partial^2 u}{\partial y^2} + \frac{\partial u}{\partial y} - \sigma\frac{\partial u}{\partial t} - N u = -G_r\theta \tag{9}$$

$$\frac{\partial^2 \theta}{\partial y^2} + \Pr\frac{\partial \theta}{\partial y} - \Pr\sigma\frac{\partial \theta}{\partial t} = -E_c \Pr\left(\frac{\partial u}{\partial y}\right)^2 - \Pr\alpha \tag{10}$$

$$N = \frac{1}{K} + M$$

Subject to the boundary conditions

$$u = 0 \quad \theta = 1 \quad on \quad y = 0$$
$$u \to 0 \quad \theta \to 0 \quad as \quad y \to \infty \tag{11}$$

The problem therefore depends on the Wormersley's parameter σ, the free convection parameter G_r, the Prandtl number P_r, the porosity parameter K, the viscous heat dissipation parameter or Eckert number Ec, the magnetic parameter or Hartmann number M, and the heat generation/absorption parameter α.

The statement of the problem is now complete.

Method of Analysis

The problem as posed in equations (9) to (11) is nonlinear and coupled therefore analytical solutions will be very difficult to obtain, however, a great deal of insight as to the flow behaviour can be obtained if we adopt a pertubative series expansion about ε, ($\varepsilon \ll 1$). As a first step to the solution of Eq (9) to (11) we assume (as in Bestman [14]) that

$$u(y,t) = u_o(y) + \varepsilon e^{i\omega t} u_1(y) + - - - - - - - \tag{12}$$

$$\theta(y,t) = \theta_o(y) + \varepsilon e^{i\omega t} \theta_1(y) + - - - - - - \tag{13}$$

Substituting Eqs (12 and 13) into Eqs (9) to (11), we find that the leading approximations satisfy the following sequence of equations

$$\theta_0'' + \Pr \theta_0' = -Ec \Pr u_0'^2 - \Pr q_0 \tag{14}$$

$$u_0'' + u_0' - Nu_0 = -Gr\theta_0 \tag{15}$$

$$\theta_1'' + \Pr \theta_1' - i\omega\sigma \Pr \theta_1 = -2Ec \Pr u_0' u_1' + \Pr q_1 \tag{16}$$

$$u_1'' + u_1' - (N + i\omega\sigma)u_1 = -Gr\theta_1 \tag{17}$$

Primes denote differentiation with respect to y. The corresponding boundary conditions now are

$$\begin{aligned}
&u_0 = 0 = u_1 \quad \theta_0 = 1 \quad \theta_1 = 0 &&on \quad y = 0 \\
&u_0 \to 1 \quad \theta_0 \to 0 \quad u_1 \to 1 \quad \theta_1 \to 0 &&as \quad y \to \infty
\end{aligned} \tag{18}$$

The nonlinear terms in Eqs (15) to (19) are multiplied by Ec in order to decouple them, since it is known that $Ec \ll 1$ for incompressible fluids it is assumed that

$$\begin{aligned}
u_0(y) &= u_0^{(0)}(y) + Ec u_0^{(1)}(y) \\
u_1(y) &= u_1^{(0)}(y) + Ec u_1^{(1)}(y) \\
\theta_0(y) &= \theta_0^{(0)}(y) + Ec \theta_0^{(1)}(y)
\end{aligned} \tag{19}$$

$$\theta_1(y) = \theta_1^{(0)}(y) + Ec \theta_1^{(1)}(y) \tag{20}$$

Substituting Eq (19) into Eqs (14) – (18), we now have

$$\theta_0^{(0)''} + \Pr \theta_0^{(0)'} = -\Pr q_1^{(0)} \tag{21}$$

$$\theta_0^{(1)''} + \Pr \theta_0^{(1)'} = -\Pr u_0^{(0)'2} - \Pr q_1^{(1)} \tag{22}$$

$$u_0^{(0)''} + u_0^{(0)'} - N u_0^{(0)} = -Gr\theta_0^{(0)} \tag{23}$$

$$u_0^{(1)''} + u_0^{(1)'} - N u_0^{(1)} = -Gr\theta_0^{(1)} \tag{24}$$

$$\theta_1^{(0)''} + \Pr \theta_1^{(0)'} - i\omega\sigma \Pr \theta_1^{(0)} = -\Pr q_{11}^{(0)} \tag{25}$$

$$\theta_1^{(1)''} + \Pr \theta_1^{(1)'} - i\omega\sigma \Pr \theta_1^{(1)} = -2\Pr u_0^{(0)} u_0^{(1)} + \Pr q_{12}^{(0)} \tag{26}$$

$$u_1^{(0)''} + u_1^{(0)'} - (N + i\omega\sigma)u_1^{(0)} = -Gr\theta_1^{(0)} \tag{27}$$

$$u_1^{(1)''} + u_1^{(1)'} - (N + i\omega\sigma)u_1^{(1)} = -Gr\theta_1^{(1)} \tag{28}$$

Eqs (21) to (28) are to be solved subject to the boundary conditions

$$\begin{aligned}
&\theta_0^{(0)} = 1, \ \theta_0^{(1)} = 1, \ \theta_1^{(0)} = 0 = \theta_1^{(1)}, \quad u_0^{(0)} = 0 = u_0^{(1)} = u_1^{(0)} = u_1^{(1)} &&on \quad y = 0 \\
&\theta_0^{(0)} = \theta_0^{(1)} = \theta_1^{(0)} = \theta_1^{(1)} = 0 = u_0^{(0)} = u_0^{(1)} = u_1^{(0)} = u_1^{(1)} &&as \quad y \to \infty
\end{aligned} \tag{29}$$

and the results are

$$\theta(y,t)= e^{-m_1 y} + Ec\left\{Ae^{-\Pr y}+a_2 e^{-2m_1 y}+a_3 e^{-2m_2 y}-a_4 e^{-\alpha y}\right\}+$$

$$\varepsilon e^{i\omega t}\left[Ce^{-m_3 y}+q_{11}/i\omega\sigma+Ec\left\{Ee^{-m_3 y}+a_{11}e^{-\alpha y}-a_{12}e^{-\alpha_1 y}-\right.\right. \tag{30}$$

$$\left.\left.-a_{13}e^{-\alpha_2 y}+a_{14}e^{-\alpha_3 y}+a_{15}e^{-\alpha_4 y}-a_{16}e^{-2m_2 y}-a_{17}e^{-3m_2 y}+a_{18}\right\}\right]$$

$$u(y,t)= a_1\left(e^{-m_2 y}-e^{-m_1 y}\right)+Ec\left\{Be^{-m_2 y}-a_5 e^{-\Pr y}-a_6 Gre^{-\alpha y}+a_7 e^{-2m_1 y}\right.$$

$$\left.+a_8 e^{-2m_2 y}\right\}+e^{i\omega t}\left[De^{-m_4 y}-a_9 e^{-m_3 y}+a_{10}+Ec\left\{Fe^{-m_4 y}-a_{19}e^{-m_3 y}\right.\right.$$

$$-a_{20}e^{-\alpha y}+a_{21}e^{-\alpha_1 y}+a_{22}e^{-\alpha_2 y}-a_{23}e^{-\alpha_3 y}-a_{24}e^{-\alpha_4 y}+a_{25}e^{-2m_2 y}$$

$$\left.\left.+a_{26}e^{-3m_2 y}-a_{27}\right\}\right] \tag{31}$$

The coefficient of skin friction is an important physical parameter for this type of boundary layer flow which we can define in non-dimensions as

$$\tau = \left.\frac{\partial u}{\partial y}\right|_{y=0} = a_1(m_1-m_2)+Ec\left\{a_5\Pr-Bm_2+\alpha a_6 Gr-2a_7 m_1-2a_8 m_2\right\}+\varepsilon e^{i\omega t}\left[a_9 m_3-Dm_4\right.$$

$$\tag{32}$$

$$\left.+Ec\left\{a_{19}m_3-Fm_4+\alpha a_{20}-\alpha_1 a_{21}-\alpha_2 a_{22}+\alpha_3 a_{23}+\alpha_4 a_{24}-2a_{25}m_2-2a_{26}m_2\right\}\right]$$

Result and discussion

The problem of unsteady free convection flow through a porous medium considering the effect of viscous dissipative heat and a uniform magnetic field is addressed in this study. To have a physical feel of the problem we present results to show how the material parameters of the problem affect the temperature, velocity and skin-friction. The value of the porosity parameter K is chosen as K = 0.2, a slightly porous medium, the value of the free convection parameter Gr, is chosen as Gr = 5 which will correspond to cooling of the plate by free convection currents, σ = 0.2. These values are not chosen in any particular order.

Figure 2: Effect of viscous dissipative heat on the temperature distribution for Pr = 0.7 and 7.0
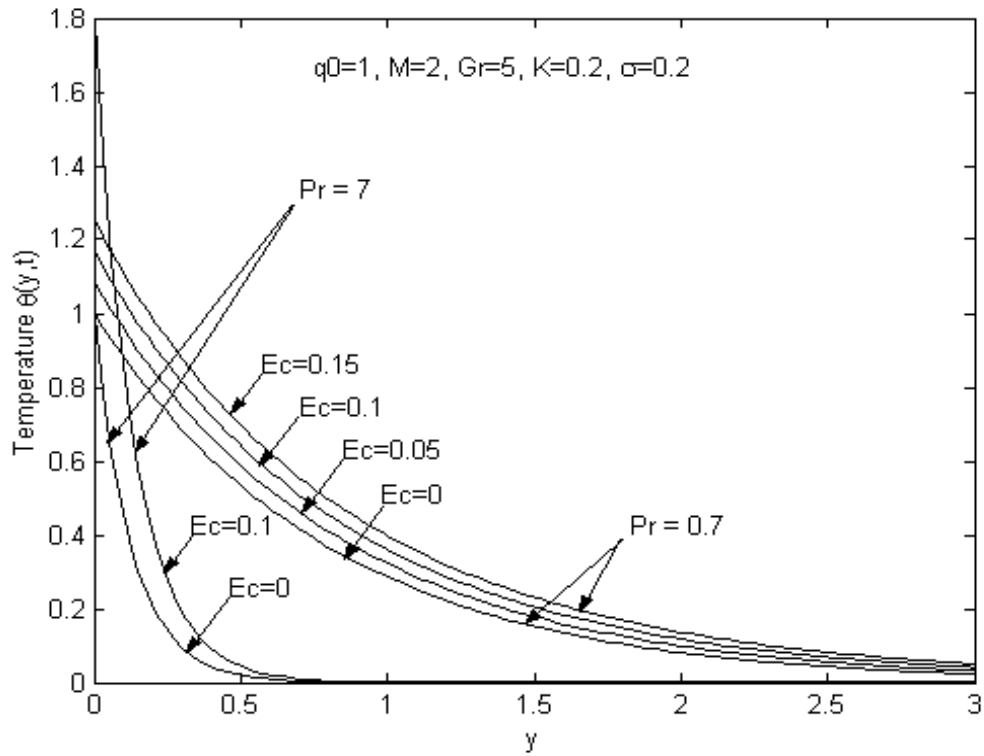
Figure 3: Effect of heat generation on the Velocity
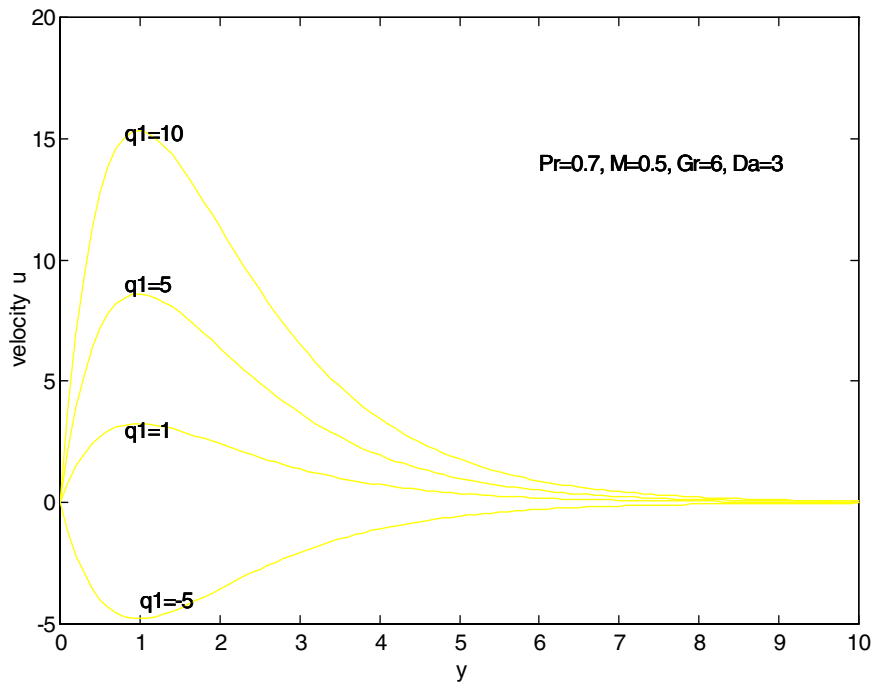
Figure 4: Effect of magnetic parameter on the Velocity distribution for Pr = 0.7 and 7
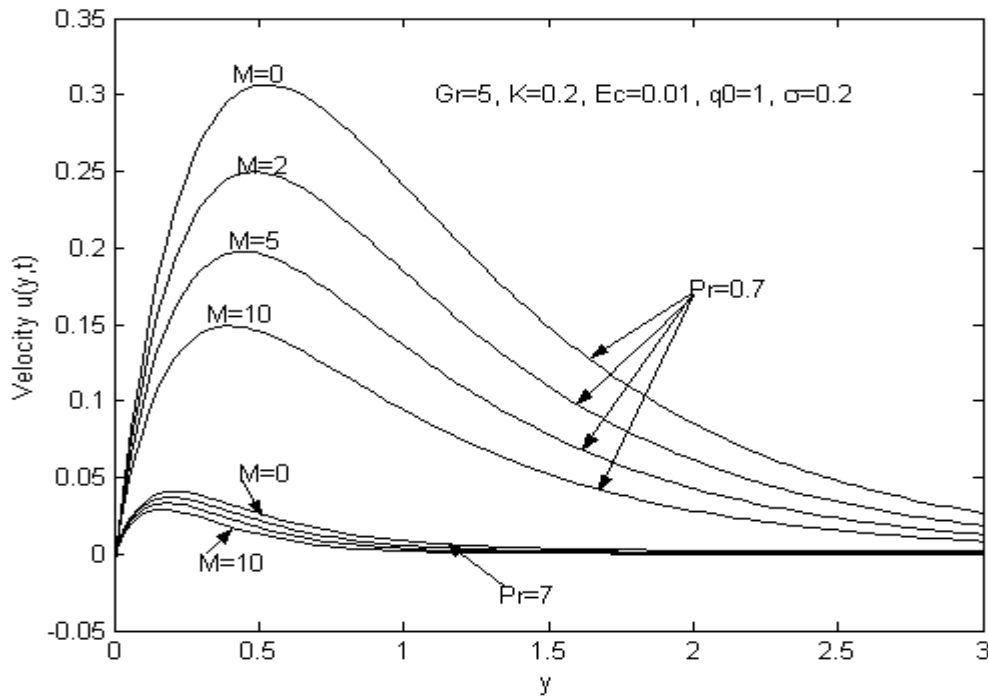
Figure 2 shows the temperature distribution for two values of the Prandtl number Pr, Pr = 0.7 as corresponds to air, and Pr = 7.1 as corresponds to water. We observe that increase in the Prandtl number leads to a decrease in the temperature, while increase in viscous dissipative heat leads to an increase in the temperature. These effects are most pronounced at the plate than down stream from the plate

The effect of material parameters on the velocity distribution are shown in figures 3 - 5. in figure 3 we observe an increase in the velocity with increase in heat generation (q positive), and a decrease in velocity, even resulting in flow reversal, with increase in heat absorption (q negative). From figures 4 and 5 we observe an increase in the velocity as both the magnetic and viscous dissipative parameters are increased, but a decrease in the velocity as the Prandtl number is increased. Increased cooling of the plate due to free convection currents, (not shown) Gr > 0, leads to an increase in the velocity. Indeed these observations are in good agreement with results in the literature.

Figure 5: Effect of viscous dissipative heat on the Velocity distribution.
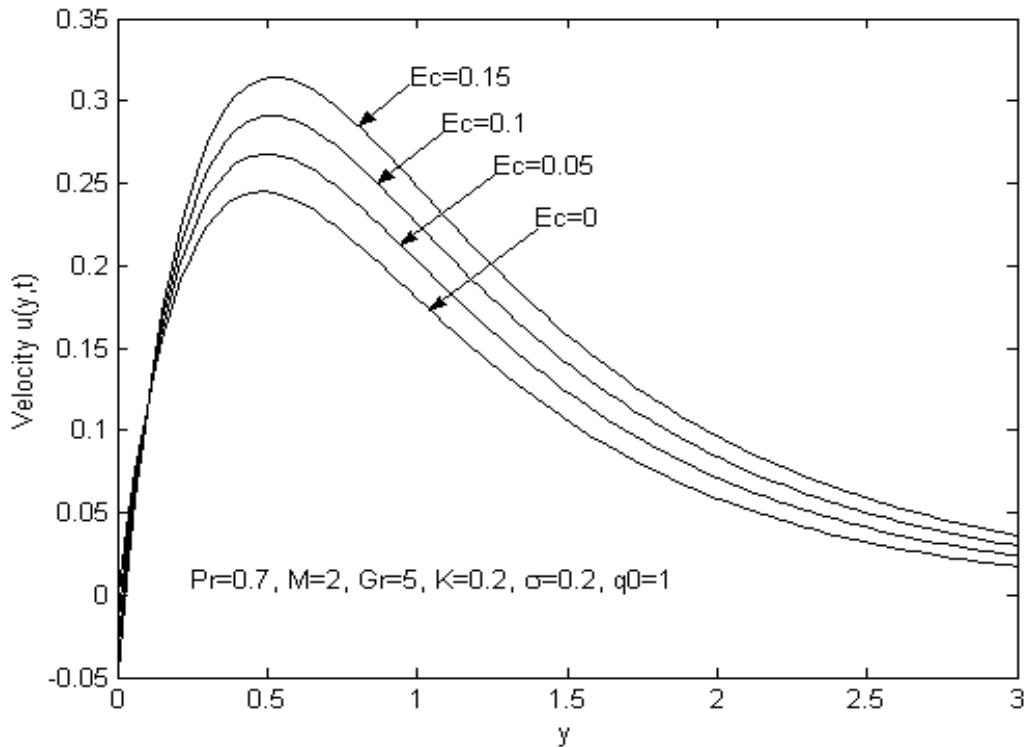
The skin friction coefficient τ, is shown in table 1 for material parameters of the problem from where we observe that τ, decreases as the magnetic parameter M increases both for cooling of the plate by free convection currents, (Gr > 0) and for heating of the plate by free convection currents, (Gr < 0) . On the other hand τ increases as the time period t or the porosity K increases for cooling of the plate and decreases as t increases for heating of the plate. Finally we observe that τ increases as the dissipative heat parameter Ec, increases.

Table 1: skin-friction coefficient, Pr = 0.7, ω = 0.4, q_o = 1

Gr	K	t	M = 2		M = 5	
			Ec=0.01	Ec=0.02	Ec=0.01	Ec=0.02
2	0.4	0.2	0.4861	0.4237	0.4825	0.4961
	0.4	0.4	0.5026	0.4402	0.4947	0.5083
-2	0.4	0.2	0.1721	0.8928	-0.4784	-0.4879
	0.4	0.4	0.1556	0.8763	-0.4906	-0.5001
5	0.2	0.2	1.2973	1.3967	1.1117	1.1545
	0.4	0.2	7.8955	14.4197	1.2494	1.3265
	0.4	0.4	7.9368	14.4610	1.2797	1.3570
-5	0.2	0.2	-1.0538	-0.9096	-1.0705	-1.0721
	0.2	0.4	-1.0855	-0.9413	-1.0964	-1.0979
	0.4	0.4	17.7754	36.9634	-1.1191	-1.0355

Concluding Remarks

From our observations above, we can conclude that

- increase in the viscous dissipative heat leads to increase in both the flow velocity and the temperature distribution,

- increase in the magnetic parameter is accompanied by an increase in the velocity, but no effect on the temperature distribution,
- the skin-friction τ, increases as the magnetic parameter or the viscous dissipative heat increase irrespective of heating (Gr < 0) or cooling (Gr > 0) of the plate by free convection currents.

References

[1]   A. R. A. Khaled and K. Vafai,, Int. J. Heat Mass Transfer 46, 4989, (2003).
[2]   V. M. Soundagekar, Proceedings of the Royal Society of London A 333, 25, (1973).
[3]   M. A. Mansour, Astrophysics and Space Science, 166, 269, (1990)
[4]   A. Raptis, Int. Comms. Heat Mass Transfer, 25, no. 2, p289, (1998).
[5]   Y. J. Kim, International Journal of Engineering Science 38, p833, (2000).
[6]   Y. J. Kim, Int. J. Heat Mass Transfer, 44, p2791, (2001).
[7]   K. A. Helmy, ZAMM. Z. Agnew. Math. Mech. 78(4), p255, (1998)
[8]   V. C. C. Raju, BotswanaJournal of Technology, 7(1), p1, (1998).
[9]   V. C. C Raju, Botswana Journal of Technology, 6(2), (1997).
[10]   C. I. Cookey, A. Ogulu and V. B. Omubo-Pepple, Int. J. Heat Mass Transfer, 46, 2305, (2003).
[11]   A. J. Chamkha, International journal of Engineering Science 42, p217, (2004).
[12]   F. S. Ibrahim, I. A. Hassanien, and A. A. Bakr, Can. J. Phys. 82, p775, (2004)
[13]   V. M. Soundalgekar and S. B. Hiremath, Astrophysics & Space Sci. 95, p163, (1983).
[14]   A. R. Bestman, J. Australian Mathematical Society Series. B vol. 30, p179, (1988).

Appendix

$$A = 1 + a_4 - a_2 - a_3 + \Pr q_0 \qquad m_1 = \frac{\Pr + \sqrt{\Pr^2 + 4\Pr q_0}}{2} \qquad D = a_9 - a_{10} \qquad b_6 = a_1 a_6 \alpha\, m_1 Gr$$

$$a_3 = \frac{b_3}{4m_2^2 - 2m_2 \Pr} \qquad a_4 = \frac{b_2}{\alpha^2 - \alpha\ \Pr} \qquad a_2 = \frac{b_1}{4m_1^2 - 2m_1 \Pr} \qquad a_5 = \frac{AGr}{\Pr{}^\wedge 2 - \Pr - N}$$

$$a_6 = \frac{a_4 Gr}{\alpha^2 - \alpha - N} \qquad a_7 = \frac{a_2 Gr}{4m_1^2 - 2m_1 - N} \qquad a_8 = \frac{a_3 Gr}{4m_2^2 - 2m_2 - N} \qquad b_4 = a_1 m_1 m_2 B$$

$$m_4 = \frac{1 + \sqrt{1 + 4(N + i\omega\sigma)}}{2} \qquad m_3 = \frac{\Pr + \sqrt{\Pr^2 + 4i\omega\sigma}}{2} \qquad a_9 = \frac{GrC}{m_3^2 - m_3 - (N + i\omega\sigma)}$$

$$a_1 = \frac{Gr}{m_1^2 - m_1 - N} \qquad b_5 = a_1 a_5 \Pr m_1 \qquad b_7 = 2a_1 a_7 m_1^2 \qquad b_8 = 2a_1 a_8 m_1 m_2 \qquad b_9 = a_1 m_2^2 B$$

$$B = a_5 + a_6 - a_7 - a_8 \qquad C = 1 - \frac{q_{11}}{i\omega\sigma} \qquad b_1 = a_1^2 m_1^2 \qquad b_2 = a_1^2 m_1 m_2 \qquad b_3 = a_1^2 m_2^2 \qquad \alpha = m_1 + m_2$$

$$m_2 = \frac{1 + \sqrt{1 + 4N}}{2} \qquad a_{10} = \frac{Grq_{11}}{i\omega\sigma N - \omega^2 \sigma^2}$$

$$b_{10} = a_1 a_5 \Pr m_2 \qquad b_{11} = a_1 a_6 \alpha\, Grm_2 \qquad b_{12} = 2a_1 a_7 m_1 m_2 \qquad b_{13} = 2a_1 a_8 m_2^2 \qquad b_{14} = b_6 - b_7 + b_{12}$$

$$b_{15} = b_8 + b_{11} \qquad \alpha_1 = m_1 + \Pr \qquad \alpha_2 = 2m_1 + m_2 \qquad \alpha_3 = 2m_2 + m_1 \qquad \alpha_4 = \Pr + m_2$$

$$a_{11} = \frac{2\Pr b_4}{\alpha^2 - \alpha\ \Pr - i\omega\sigma \Pr} \qquad a_{12} = \frac{2\Pr b_5}{\alpha_1^2 - \alpha_1 \Pr - i\omega\sigma \Pr} \qquad a_{13} = \frac{2b_4 \Pr}{\alpha_3^2 - \alpha_3 \Pr - i\omega\sigma \Pr}$$

$$a_{14} = \frac{2\Pr b_5}{\alpha_4^2 - \alpha_4 \Pr - i\omega\sigma \Pr} \qquad a_{15} = \frac{2\Pr b_{10}}{\alpha_5^2 - \alpha_5 \Pr - i\omega\sigma \Pr} \qquad a_{16} = \frac{2\Pr b_9}{4m_2^2 - 2m_2 \Pr - i\omega\sigma \Pr}$$

$$a_{17} = \frac{2\Pr b_{13}}{9m_2^2 - 3m_2 - i\omega\sigma \Pr} \qquad a_{18} = \frac{q_{12}}{i\omega\sigma} \qquad a_{19} = \frac{EGr}{m_3^2 - m_3 - (N + i\omega\sigma)}$$

$$a_{20} = \frac{Gra_{11}}{\alpha^2 - \alpha - (N + i\omega\sigma)} \qquad a_{21} = \frac{Gra_{12}}{\alpha_1^2 - \alpha_1 - (N + i\omega\sigma)} \qquad a_{22} = \frac{Gr\,a_{13}}{\alpha_2^2 - \alpha_2 - (N + i\omega\sigma)}$$

$$E = 1 - a_{11} + a_{12} + a_{13} - a_{14} - a_{15} + a_{16} + a_{17} - a_{18}$$

$$F = a_{19} + a_{20} - a_{21} - a_{22} + a_{23} + a_{24} - a_{25} - a_{26} + a_{27}$$

$$a_{23} = \frac{Gr\,a_{14}}{\alpha_3^2 - \alpha_3 - (N + i\omega\sigma)} \qquad a_{24} = \frac{Gr\,a_{15}}{\alpha_4^2 - \alpha_4 - (N + i\omega\sigma)} \qquad a_{25} = \frac{Gr\,a_{16}}{4m_2^2 - 2m_2 - (N + i\omega\sigma)}$$

$$a_{26} = \frac{Gr\,a_{17}}{9m_2^2 - 3m_2 - (N + i\omega\sigma)} \qquad a_{27} = \frac{Gr\,a_{18}}{N + i\omega\sigma}$$

Gender and Alcohol Consumption Affect Human Serum Enzymes, Protein and Bilirubin

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Abstract

Objective: The effects of gender and alcohol consumption on serum enzymes, protein and bilirubin in heavy, moderate and non-drinkers were investigated.

Method: Seven-two healthy human subjects were divided equally into males and females. They were categorized as heavy, moderate and non-drinkers, using carefully structured questionnaires .Whole blood was taken via puncture of the cubical vein and serum protein, albumin, total and direct bilirubin concentrations were determined using Synchron CX 5 autoanalyzer. The activities of serum aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and gamma glutamyl transferase were assayed.

Results: The age and body mass index of the males and females were 45.60 + 1.80years, 22.16+0.83 kg/m^2 and 43.87+2.46 years, 20.78 +1.03 kg/m^2 respectively. Serum protein, albumin and bilirubin levels were significantly different in both male and female heavy and moderate drinkers. The activities of serum aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and gamma glutamyl transferase in the non-drinkers were significantly lower than in moderate or heavy drinkers of alcohol in both males and females.

Conclusion: These findings indicate that alcohol consumption either as chronic or moderate, elevated the activities of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase and gamma glutamyl transferase in both males and females, but more pronounced in the females. Serum protein, albumin and bilirubin levels were impaired by alcohol consumption in both males and females, and may provide additional information in the diagnosis and management of alcoholism.

Keywords: Alcohol consumption, gender, serum enzymes, protein, albumin, bilirubin

Introduction

Worldwide adults consume on average 5 litres of pure alcohol from beer, wine and spirits per year. The average alcohol consumption is highest in Europe , followed by the America and by Africa. It tends to increase with economic development. However consumption remains low in some regions where the majority of the population is muslim (WHO, 2004).

Alcohol consumption has been reported to be associated with cardiovascular morbidity and mortality in a dose-dependent manner (Kalousova *et al.* 2004). Intake of moderate alcohol has protective effects by decreasing coronary heart disease mortality, while excessive alcohol misuse has detrimental effects on the cardiovascular system, which can result in cardiomyopathy, coronary heart disease or hypertension and haemorrhagic stroke (Klatsky *et al.* 1990).Alcohol may accelerate oxidative stress directly or indirectly, which may increase cell death modification of biological structures and tissue damage. Free radicals are formed in chain reactions with the contribution of cytochromes, as a result of mitochondrial damage and due to decreased antioxidant defence mechanisms (Sun *et al.* 2001).

There is an increasing interest in the potential effects of alcohol consumption on human hearts worldwide. (Oyama *et al,*. 2000). For instance, acute or chronic alcohol consumption causes degeneration in different internal organs and systems of adults (Brailowsky and Garcia, 1999). Maternal alcohol consumption affects different organs and systems of the developing fetus (Dencker and Eriksson, 1998).Due to these adverse effects, some functional disorders of these organs occur frequently. For example, alcohol consumption is known to cause diarrhea, other gastro-intestinal symptoms and in advanced states, decreased body weight (Mezey, 1985, Apte yet. Al. 1997, Zakhari, 1997).

It has been reported that high consumption of alcohol results in malnutrition, depending on the possible changes in intestinal absorption mechanisms and dysfunction of some organs, such as, the liver and pancreas (Mezey,1985,). In addition, maternal alcohol consumption during gestation is known to cause fetal growth retardation in humans and laboratory animals (Lin, 1991), an effect persisting for a long period affect parturition (Oyama *et al*. 2000).The exact mechanism by which alcohol causes growth retardation is not known, evidences indicate that ethanol interacts with nutrients (Lin, 1991).

Despite the extensive literature on the hepatic effects of ethanol, its influence on gender or sex and serum enzymes, bilirubin and proteins in human is not clearly understood. There has been an increase in alcohol consumption in recent years apparently among women, men and adolescents of both sexes and has posed a major public health concern. Alcohol consumption is the leading risk factor for disease burden in low mortality developed countries (Rehm and Eschmann, 2002). Alcohol causes 1.8 million deaths (3.2% of total) and a loss of 58.3 million (4% of total of disability-adjusted life years (WHO, 2002) .The aim of our study was to determine whether gender and alcohol consumption affect serum enzymes, bilirubin and proteins in humans.

Methods

Study Design: The subjects used in the study were males and females, who were heavy drinkers, moderate drinkers and non-drinkers of alcohol (Table 1). They were categorized as heavy, moderate and non-drinkers after interview and administration of carefully structured questionnaires, containing general questions on age ,sex, height, weight, type, quantity ,duration of drinking alcohol ,attitudes to health issues and alcohol habits. The body mass index (BMI) was estimated as body weight (in kilograms) divided by height squared (in meters).The amount of self-reported alcohol intake per week was estimated from the answers to the following questions in the questionnaires, such as how much beer, wine or spirits do you drink on average during an ordinary week.

Table 1: Characteristics of heavy , moderate and non-drinkers of alcohol.

Characteristic	Male	Female
Number of participants	36	36
Heavy drinker	12	12
Moderate drinker	12	12
Non-drinker	12	12
Age of participants (years)	45.10 ± 1.84	43.87± 2.46
Body Mass Index (kg / m^2)	22.75 ± 1.38	20.47± 1.69

The heavy drinkers goes beyond what is considered moderate or socially acceptable. They admitted to a daily intake which ranged from 4-6 pints of beer to 3-5 bottles of whisky or other spirits, for over 20 years. Heavy drinking was defined in terms of exceeding a certain daily volume (e.g., three drinks a day) or quantity per occasion (e.g., five drinks or an occasion at least once a week) or daily drinking. The moderate drinkers were those who drinks alcohol in very small quantities and irregularly, such as once or twice weekly, for over 20 years. The non-drinkers served as controls, and have not drank any alcoholic beverages, such as beer, wine, distilled spirit and liquors, containing ethyl alcohol.

The subjects consisted of 24 heavy drinkers with history of continuous or periodic heavy alcohol abuse, 24 moderate drinkers and 24 non-drinkers. Each category comprises 12 males and females, and the age brackets of the males and females were 45.60+1.84 years and 43.87+2.46 years , respectively (Table 1). The nutritional status of the subjects and controls were assessed based on the dietary history ,body weight ,BMI ,serum protein and albumin levels.(Wardlaw and Kessel,2002).None of the subjects suffered from obesity ,liver cirrhosis or alcohol hepatitis in the history .All patients were otherwise healthy (no diabetes mellitus, nor alteration of liver and renal function) and had no signs of acute infection .All the subjects and controls were drug free prior to a minimum of two weeks before the study commenced. The study was approved by the local institutional Ethical Committee and all subjects gave their informed consents prior to entering this study.

Blood Chemistry and Enzyme Assay: Blood was collected via puncture of the cubital vein between 0830h and 0930h after an overnight fast, and centrifuged at 3000 g , 4ºC for 10min.Serum was extracted and the concentrations of protein ,albumin ,total and direct bilirubin of the heavy drinkers ,moderate drinkers and non-drinkers were determined, using Synchron CX5 autoanalyzer .The activities of serum aspartate aminotransferase (AST ,EC 2.6.1.1), alanine aminotransferase (ALT, EC 2.6.1.2), alkaline phosphatase (EC 3.1.3.1) and gamma –glutamyl transferarse (GGT , EC 2.3.2.2.), were analyzed at 37ºC according to the recommended principles (Steffensen *et al.* ,1977) and using commercial kits manufactured by Boehringer, Mannheim ,Germany and Roche, Switzerland.

Statistical Analysis

The Student's t –test and analysis of variance were used to analyze the data for significant differences. Microsoft Excel XP 2002 software was utilized.

Result

The characteristics of heavy drinkers, moderate drinkers and non-drinkers of alcohol, used for the study are presented in Table I. The age brackets of the males and females were 45.60 ± 1.84 years and 43.87 ± 2.46 years. The body mass index of the males and females were 22.16 ± 0.83 kg/m^2 and 20.78 ± 1.03 kg/m^2. The BMI of the males was higher than in females.

The concentrations of serum protein, albumin, total and direct bilirubin of heavy drinkers, moderate drinkers and non-drinkers of alcohol are shown in Table 2. There were significant ($p < 0.01$) differences in the levels of serum protein , albumin, total bilirubin and direct bilirubin in the male and female heavy, moderate and non-drinkers. The serum protein and albumin levels of the males and females, were significantly higher in the non-drinkers as compared to the moderate or heavy drinkers. The serum protein and albumin levels of the heavy drinkers were significantly lower than in the

moderate drinkers. Total and direct bilirubin levels significantly higher in the heavy and moderate drinkers than in non-drinkers, in both males and females (Table 2).

Table 2: Serum protein, albumin and bilirubin concentrations of heavy drinkers, moderate drinkers and non-drinkers of alcohol.

Alcohol Status	Protein (g/dl)	Albumin (g/dl)	Total bilirubin (mg/dl)	Direct bilirubin (mg/dl)
Heavy drinker				
Male	6.34± 0.09	3.31± 0.02	0.91 ±0.04	0.33±0.03
Female	5.71± 0.04	2.62± 0.06	1.03±0.02	0.41±0.05
Moderate drinker				
Male	7.01±0.02	3.92±0.05	0.63±0.08	0.21±0.07
Female	6.62±0.01	3.57±0.01	0.52±0.03	0.15±0.01
Non-drinker				
Male	7.44±0.04	4.52±0.01	0.42±0.01	0.12±0.03
Female	7.25±0.05	4.36±0.08	0.25± 0.02	0.10±0.01

Table 3: Serum enzymes activities of heavy drinkers, moderate drinkers and non-drinkers of alcohol.

Alcohol Status	AST (U/l)	ALT (U/l)	ALP (U/l)	GGT (U/l)
Heavy drinker				
Male	19.4 ± 0.72	17.6 ± 2.08	41.4 ± 5.62	69.1 ± 4.08
Female	33.6 ± 1.18	25.7 ± 1.62	49.7 ± 6.03	84.5 ± 5.12
Moderate drinker				
Male	13.2 ± 0.41	10.50 ± 0.56	36.4 ± 3.07	52.6 ± 5.83
Female	12.1 ± 0.61	8.40 ± 0.72	32.3 ± 4.21	50.4 ± 4.05
Non-drinker				
Male	6.90 ± 0.06	4.60 ± 0.08	5.23 ± 0.06	38.2 ± 1.40
Female	8.10 ± 0.05	5.31 ± 0.02	6.10 ± 0.09	24.1 ± 0.85

(aspartate aminotransferase (AST), alanine aminotransferase (ALT) ,alkaline phosphatase (ALP), gamma glutamyl transferase (GGT)

The activities of serum enzymes of heavy, moderate and non-drinkers of alcohol are presented in Table 3.The activities of serum aspartate aminotransferase(AST) ,alanine aminotransferase (ALT), alkaline phosphatase (ALP) and gamma glutamyl transferase (GGT) in the non-drinkers were significantly lower than in moderate or heavy drinkers of alcohol, in both males and females.The activities of AST, ALT, ALP and GGT of the heavy drinkers were significantly higher than in moderate drinkers of both males and females. However the variation in the activities of these enzymes were more pronounced in the female heavy or moderate drinkers as compared to the male counterparts (Table 3).

Discussion

The body mass index (BMI) of the heavy, moderate and non-drinkers of alcohol were less than 25 , which indicates that they were in no risk for body weight -related health disorders, such as obesity. The BMI corresponded within acceptable range of 18.50-24.90 (Wardlaw and Kessel, 2002).Serum albumin levels of the heavy, moderate and non-drinkers of alcohol were within the recommended limits indicating that they were not malnourished. However, alcohol consumption impaired the levels of serum protein, albumin, total and direct bilirubin in both males and females. The adverse effects of alcohol intake were more pronounced in both total and direct bilirubin levels in both males and females.Our results are in agreement with previous reports , which indicated that acute alcohol caused a significant reduction in the concentrations of plasma total protein and albumin in humans(Marway *et al*.,1993,Whitehead *et.al*.,1978,Zakhari,1997,Sun *et.al*.2001).).

Data suggest that alcohol consumption may inhibit protein synthesis, especially in the heavy drinkers. The binding and transport of substances by albumin, such as bilirubin could be affected by

heavy or moderate alcohol consumption ,especially in females. Bilirubin is transported to the liver by binding non-covalently to albumin (Wardlaw and Kessel, 2002).From the present study, both conjugated (direct) and total bilirubin levels were more reduced than albumin or protein levels in both male and female heavy or moderate drinkers than in non-drinkers.

The activities of AST, ALT, ALP and GGT ,which are serum liver derived enzymes in the heavy and moderate drinkers in both males and females, were elevated as compared to the non-drinkers.This finding suggests the possibility of alcohol abuse ,which might pose a threat to liver damage and disease.The results concur with previous reports (Patel and O'Gorman ,1975, Steffenson *et al* .1997, Nishimura *et al*. 1980, Nemesanezky *et al*. 1988, Sun *et al*. 2001). The activities of these serum liver enzymes were more raised in in females than in males .This may be due to certain differences in the physiological and endocrine systems in both males and females.

Biochemical diagnostic tests of liver function are numerous, but the activities of AST, ALT and GGT are frequently used in general practice for assessing liver function in health screening and in patients with non-specific symptoms (Nishimura *et.al*.1980, Steffensen *et. al*. 1997). Since usage of questionnaires and self-reporting are commonly unreliable laboratory tests of the activities of AST, ALT and GGT, have been proposed as indicators of alcohol abuse.For instance, GGT catalyzes the transfer of gamma glutamyl group from peptides containing it to other peptides and to L-amino acids. It has been reported to be sensitive and fairly specific indicator of liver disease (Patel and O'Gorman 1975, Nishimura *et. al* .,1980).

Excessive alcohol consumption is widely associated with liver damage (Heathcole, 2000, AGA, 2002, Apte *et. al*. 1997). Alcohol can cause physical, mental and social effects which are determined by both quantity consumed and pattern of drinking. Alcohol affects practically every organ in the body and its consumption has been linked to more than 60 disease conditions (Ridolfo and Stevenson 2001, Zakhari 1997, Apte *et. al* .1997, Ebuehi *et al* .1997, Boyer,1972).

Too little is known about the influence of ethanol , whether heavy or moderate , on the synthesis and release of liver enzymes at the cellular level.The toxic effects of ethanol on hepatocytes ,pancreatic and aciner cells , and so on , are well documented (Nemesanesky *et al*.1988, Whitehead *et al*.,1978).Some of the present findings in this study are in harmony with previous workers(Patel and O'Gorman ,1975, Steffenson *et al* .1997, Nishimura *et al*. 1980, Nemesanezky *et al*. 1988, Sun *et al*. 2001), but data on the effects of heavy or moderate alcohol consumption in the females , are relatively new contributions to the existing body of knowledge.

Data of the present study indicate that serum protein, albumin, total and direct bilirubin levels are impaired by heavy or moderate alcohol consumption. The activities of serum AST, ALT, GGT, ALP are good indicators of alcohol abuse. These effects are gender –dependent. However, the adverse effect of alcohol consumption is more detrimental to the females than in males, therefore ,gender or sex factor may be relevant in the diagnosis and management of alcoholism.

References

[1]   American Gastroenterological Association (AGA, 2002).Medical position statement: evaluation of liver chemistry tests.Gastroenterology, 123:1364-1366.

[2]   Apte, M.V., Wilson, J.S. and Korsten, M.A.(1997).Alcohol-related pancreatic damage: mechanisms and treatment . Alcohol Health and Research World, 21 (1): 13-20.

[3]   Boyer J.L(1972).Effect of chronic ethanol feeding on bile formation and secretion of lipids in the rat. Gastroenterology, 62 : 294-301

[4]   Brailowsky, S. and Garcia, O.(1999).Ethanol GABA and epilepsy. Arch. Med. Res.30:3-9

[5]   Carey, W.D. (2003). Disease Management Project .A guide to commonly used liver tests . The Cleveland Clinic Foundation , p45--89.

[6]   Dencker, L. and and Eriksson , P. (1998). Susceptibility in utero and neonatal exposure .Food Addit. Contam. 15 (Suppl.):37-43.

[7]   Ebuehi, O.A.T., Majekodumi, O.B.and Ebuehi, O.M.(1997).Effect of Ethanol and Bromazepam in monoamine oxidase activity in rats brain . Biokemistri, 7 (2) :115-127

[8]   Heathcote, E.J.(2000).Management of primary biliary cirrhosis. The American Association for the study of Liver diseases . Practice guidelines. Hepatology, 31 : 1005-1013

[9]   Kalousova, M, Zinia, T, Popov, P, Spacek, P, Braun, M, Soukupova, J, Pelinkova, K, Kientsch-Engel, R.(2004).Advanced glycation end –products in patients with chronic alcohol misuse. Alcohol and Alcoholism, 39 (4) : 316-320.

[10]   Klatsky, A.L, Armstrong, M.A. and Friedman, G.D. (1990). Risk of cardiovascular mortality in alcohol drinkers, ex-drinkers and non-drinkers. American Journal of Cardiology, 66: 1237-1242.

[11]   Lin, G.W.(1991). Maternal –fetal folate : effect of ethanol and dietary folate deficiency. Alcohol 8 :169-172

[12]   Marway J.S., Keating, J.W., Reeves,J., Salisbury,J.R.and Preedy,V.R.(1993). Seromuscular and mucosal protein synthesis in various anatomical regions of the rat gastrointestinal tract and their response to acute ethanol toxicity. Eur. J. Gastroenterol. & Hepatol. 5 : 27-34

[13]   Mezey, E.(1985).Effect of ethanol on intestinal morphology. In Seitz ,H.K.Kommerell,B. (eds.).. Alcohol related diseases in gastroenterology, Springer Average. ,Berlin.

[14]   Nemesanezky, E, Lott ,J.A. and Arato ,M.(1988).Changes in serum enzymes in moderate drinkers after an alcohol challenge .Clin. Chem. 34 (3):525-527.

[15]   Nishimura, M, Hasumura, Y. and Takeuchi, J.(1980).Effect of an intravenous infusion of ethanol on serum enzymes and lipids in patients with alcoholic liver disease. Gastroenterology, 78: 691-695.

[16]   Oyama, L.M.,Couto,G.E. ,Damaso,A.R.,Oller do Nascimento ,C.M. (2000).Ethanol intake during lactation .11. Effects on pups' liver and brain metabolism.Alcohol 21 :201-206

[17]   Patel, S .and O'Gorman , P. (1975). Serum enzyme levels in alcoholism and drug dependency . J. Clin. Path. 28:414-417

[18]   Rehm, J. and Eschmann, S. (2002). Global monitoring of average volume of alcohol consumption .*Sozialund Pruventirmedizin* 47 (1): 48-58.

[19]   Ridolfo, B. and Stevenson, E.E. (2001).The quantification of drug caused mortality and morbidity in Australia , Canberra, Australia Institute of Health and Welfare, p24-34

[20]   Steffensen, F.M, Sorensen, H.T, Brock, A, Vilstrup, H. and Lauritzen, T.(1997). Alcohol consumption and serum liver derived enzymes in a Danish population aged 30-50 years. Intern. J. Epidemiology, 26 (1): 92-99.

[21]   Sun, AY, Ingelman-Sundberg, M, Neve, E, Matsumolo, H, Nishitani, Y, Minowa, Y, Fukui, Y, Bailey, SM, Patel, V.B, Cunningham, C.C, Zinia, T, Fialova, L, Mikulikova, L, Popov, P, Malbohan, I, Janebova, M, Nespor, K and Sun, G.Y. (2001).Ethanol and oxidative stress in alcoholism . Clinical and Experimental Research, 25: 2375-2435.

[22]   Wardlaw,G.W.and Kessel, M.(2002).Perspectives in Nutrition ,5th Ed., McGraw Hill Publishers, Boston ,USA, p520-534.

[23]   Whitehead, T.P., Clarke, C.A. and Whitfield, A.G .(1978).Biochemical and haematological markers of alcohol intake. Lancet i: 978-981

[24]   WHO (2002). The World Health Organization Report 2002-Reducing Risks, Promoting Healthy Life, Geneva,, p10-15.

[25]   WHO (2004).Management of substance abuse. Global Status Report on Alcohol . Part I, p 9-21

[26]   Zakhari, S. (1997).Alcohol and the cardiovascular system, molecular mechanisms for beneficial and harmful action .Alcohol Health and Research World, 21 : 21—29

Phytochemical Analysis of Potato Plants Grown Under Cycles of Light and Darkness for Gibberellic Acid Content

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Abstract

The sensitivity of gibberellic acid biosynthesis to light and darkness during tuber induction of Russet Burbank potato plants was probed by high performance liquid chromatography and by combined gas chromatography-mass spectrometry. Plants were grown under tuber non-inducing conditions before a subset of the plants was transferred to inducing conditions. Plants were harvested at regular intervals for gibberellic acid analysis during the ten days after transfer. The content of gibberellic acid declined under tuber inducing conditions and remained essentially unchanged under non-inducing conditions. Under tuber inducing conditions, gibberellic acid levels were similar during a light period and the night period that followed. Under tuber non-inducing conditions, on the other hand, gibberellic acid content increased during daylight and declined at the end of a subsequent dark period. Our data suggest that an unknown endogenous tuber inducing stimulus might play a role in the control of gibberellic acid biosynthesis under tuber inducing conditions, and that the rate of gibberellic acid degradation might be determined by the extent to which the tuber inducing stimulus accumulates during the day.

Keyword: gibberellic acid, photoperiod, plant hormone, potato, temperature

Introduction

Gibberellic acid (GA_3), whose structure is shown in Figure 1, is regarded as an endogenous plant growth hormone with a diverse range of physiological functions not yet fully elucidated [1-3].

Figure 1: Molecular structure of gibberellic acid
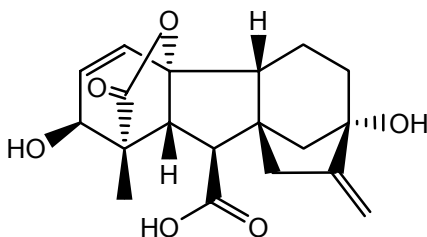
We reported previously [4] on a comparative analysis of GA_3 accumulation at the whole-plant level in potato (*Solanum tuberosum* cultivar Russet Burbank) grown in tuber inducing (10-hour

photoperiod at 24 ºC, 14-hour darkness at 12 ºC) and non-inducing conditions (18-hour photoperiod at 30 ºC, 6-hour darkness at 26 ºC). The endogenous level of GA_3 increased in plants grown in tuber non-inducing conditions compared to a rapid decline of GA_3 level upon transfer of the non-induced plants to tuber inducing conditions [4]. The conclusions from our previous work [4] only apply to plants grown under a specific set of environmental conditions and were harvested every 48 hours during a sampling period of 10 days.

The present work is primarily designed to determine how endogenous GA_3 varies with alternating periods of light and darkness especially when such recurring feature in the environment is necessary for tuber induction. Our aim was to measure the content of GA_3 that is normally found in potato plants (i) at the end of a light period (dusk) and (ii) at the end of a subsequent dark period (dawn) with a day/night cycle time of 24 hours and over a tuber induction period of 10 days. To the best of our knowledge, such a comparative study has not been reported previously.

A study of the influence of day-night alternating cycles on GA_3 production in potato plants may provide a possible explanation of why potato plants are dependent on both light and darkness with respect to the regulation of tuberization time. Such a study may contribute to the research efforts of plant scientists in discovering the tuberization mechanism of the potato plant.

Materials and Methods

Plants were grown as published elsewhere [4] under tuber inducing (10-hour photoperiod at 24 ºC, 14-hour darkness at 12 ºC) and non-inducing conditions (18-hour photoperiod at 30 ºC, 6-hour darkness at 26 ºC). Plants were harvested immediately before lights-off at the end of the photoperiod and immediately before lights-on at the end of a dark period. Plants were cut at the root-shoot junction, freeze-dried, and subjected to purification by solvent extraction and reversed-phase high performance liquid chromatography as reported elsewhere [4]. Quantification of GA_3 was achieved by combined gas chromatography-mass spectrometry exactly as described previously [4].

Result and Discussion

We determined the levels of GA_3 in both induced and non-induced plants in response to light, darkness, and temperature variation. We looked specifically for correlations between GA_3 content and a succession of day-night cycles over a period of 10 days.

Tables 1 and 2 summarize the results with chromatographically purified GA_3. It is apparent from the data that the daily biosynthesis of GA_3 is much higher in non-inducing conditions than in inducing conditions. At the same time, GA_3 was more abundant in the aerial part of the plants than in the underground part thus supporting the translocation theory of plant hormones [5, 6]. Furthermore, GA_3 is biosynthesized between sunrise and dusk before nightfall. The data also suggest that the metabolism of GA_3 is confined mostly to the dark period.

Table 1: Levels of gibberellic acid (GA_3) in potato tissues under tuber non-inducing conditions

Harvest Days	Amount (ng GA_3 / g dry tissue)[a,b]			
	Day Time Levels		Night Time Levels	
	Aerial	Underground	Aerial	Underground
1	660.3 ± 4.0 a	470.8 ± 3.7 a	500.0 ± 4.1 a	320.2 ± 3.1 a
2	670.8 ± 5.1 a	465.6 ± 3.7 a	495.2 ± 3.7 a	325.3 ± 3.9 a
3	658.0 ± 3.8 a	475.2 ± 3.4 a	499.0 ± 3.1 a	315.2 ± 2.0 a
4	663.6 ± 3.4 a	468.0 ± 4.6 a	510.4 ± 3.4 a	330.5 ± 3.2 a
5	655.2 ± 4.9 a	457.4 ± 5.4 a	515.6 ± 4.4 a	335.7 ± 3.9 a
6	685.6 ± 4.2 a	470.0 ± 5.1 a	510.0 ± 4.4 a	328.2 ± 3.6 a
7	666.8 ± 6.4 a	474.4 ± 4.2 a	520.6 ± 5.4 a	340.7 ± 4.2 a
8	675.9 ± 3.9 a	462.4 ± 5.3 a	515.4 ± 4.8 a	334.8 ± 4.9 a
9	680.8 ± 5.6 a	458.8 ± 4.1 a	525.6 ± 4.0 a	318.9 ± 5.0 a
10	674.8 ± 4.5 a	469.6 ± 4.3 a	522.6 ± 4.7 a	329.0 ± 4.3 a
Mean[c]	669.2 w	467.2 y	511.4 x	327.9 z

[a]The data are presented as the mean ± standard deviation of three replicates (two independent determinations per replicate)
[b]Mean values followed by the same letter within a column are not significantly different by Duncan's multiple-range test at *P < 0.05*
[c]Mean values in the last row with different letters (wxyz) are significantly different by Duncan's multiple-range test at *P < 0.05*

Table 2: Levels of gibberellic acid (GA3) in potato tissues under tuber inducing conditions

Harvest Days	Amount (ng GA_3 / g dry tissue)[a,b]			
	Day Time Levels		Night Time Levels	
	Aerial	Underground	Aerial	Underground
1	570.8 ± 5.0 a	350.8 ± 3.4 a	500.0 ± 4.0 a	320.2 ± 2.9 a
2	350.7 ± 5.1 b	200.6 ± 2.7 b	350.2 ± 5.4 b	200.3 ± 2.9 b
3	350.0 ± 5.6 b	200.2 ± 1.4 b	350.0 ± 4.3 b	200.2 ± 3.0 b
4	250.5 ± 3.6 c	150.0 ± 3.6 c	250.4 ± 5.5 c	150.5 ± 3.2 c
5	200.2 ± 2.9 d	102.4 ± 2.3 d	200.6 ± 4.0 d	100.7 ± 2.5 d
6	200.0 ± 3.8 d	100.0 ± 4.0 d	206.6 ± 4.0 d	101.9 ± 2.2 d
7	207.6 ± 4.1 d	105.4 ± 3.9 d	209.4 ± 3.5 d	108.4 ± 2.9 d
8	210.2 ± 3.9 d	109.4 ± 4.1 d	210.0 ± 3.8 d	110.2 ± 2.4 d
9	212.0 ± 5.2 d	111.1 ± 3.5 d	210.2 ± 3.4 d	103.5 ± 3.0 d
10	216.0 ± 4.8 d	104.8 ± 3.8 d	200.8 ± 3.2 d	104.6 ± 3.1 d
Mean[c]	276.8 w	153.5 y	268.8 x	150.1 z

[a]The data are presented as the mean ± standard deviation of three replicates (two independent determinations per replicate)
[b]Mean values followed by the same letter within a column are not significantly different by Duncan's multiple-range test at *P < 0.05*
[c]Mean values in the last row with different letters (wxyz) are significantly different by Duncan's multiple-range test at *P < 0.05*

The present study reinforces our previous data on GA_3 content of Russet Burbank potato plants in which we have found negative correlation between levels of GA_3 and tuber induction [4]. Short days and relatively low temperatures which stimulate the process of tuber induction were concomitant with lower levels of GA_3. On the other hand, long days and relatively high temperatures which inhibit tuber induction were associated with higher GA_3 content. Therefore, we have confirmed in this report our previous suggestion that GA_3 has an inhibitory role in potato tuber induction [4].

Under non-inducing conditions, as shown in Table 1, the data on an increase in GA_3 concentration during the day support the notion that light in general has a positive effect on GA_3 level as compared to dark treatments. Although we do not know the mechanistic basis for these effects, it would be logical to assume that the enzymes catalyzing the biosynthesis of GA_3 are inactive at night. For example, it is shown in Table 1 that after each night of the sampling period, approximately 30% of GA_3 degraded in the dark. When plants were exposed to subsequent 18 hours of light, the biosynthesis rate increased to 30%. However, no pronounced changes in GA_3 overall content occurred throughout the 10 day harvest period. The effect of light and darkness was repeatedly reversible under non-inducing conditions thus indicating that photo-reversibility of GA_3 biosynthesis might be regulated by a phytochrome photocycle system. Such observations support the hypothesis that phytochrome is

involved in regulation of tuber induction [7-14] by producing a graft-transmissible inhibitor of tuberization [6, 12].

Phytochrome is a system of photoreceptors which stimulate certain photosensory pathways resulting in various biosynthetic processes. Phytochrome senses and responds to the quantity and quality of the incident light at the appropriate temperature [15, 16]. Red and far-red lights are two components of the spectrum of sun light with pronounced effects on tuber induction [7-8]. During the day, when the red/far-red ratio is high enough, red light generates the active form of the phytochrome [17-23]. At night, when far-red light flux predominates, the phytochrome converts back to its original inactive form [17-23]. This resembles the inhibition of tuberization by red light and reversal of the effect of red light by far red light given immediately after exposure to red light [7].

The content of GA_3 quickly dropped upon exposure to inducing conditions of shorter days and cooler temperatures as presented in Table 2. It is perhaps surprising that GA_3 levels did not significantly differ between any consecutive light and dark periods within a 24-hour tuber inducing cycle (Table 2). This may suggest that the metabolism of GA_3 under inducing conditions does not occur until after a cycle of 24 hours of night time keeping and day time keeping.

We also found a substantial reduction in the level of GA_3 in induced plants after the first five cycles of light and dark periods. Between days 5 and 10 the content remained primarily constant. Small tubers were observed after 8 days of inducing conditions in our experiment. These observations suggest that a tuber inducing stimulus [5, 6, 24] was produced under inducing conditions with inhibitory effects on the biosynthesis of GA_3. Once the level of this stimulus reaches a certain threshold, the biosynthesis of GA_3 is stopped by the action of the stimulus. For example, the inhibitory effect of GA_3 was suppressed by abscisic acid [25]. Since longer days and higher temperatures led to increased GA_3 biosynthesis, and because exogenous jasmonic acid caused tuberization under non-inducing conditions [26, 27], we propose that jasmonic acid may have a role in the inhibition of GA_3 biosynthesis. However, this proposal requires experimental testing and we hope to report on this in due course. The nature and extent of interactions between GA_3 and the stimulus remains to be characterized.

Conclusion

We have addressed the question of whether GA_3 content of Russet Burbank potato plants might vary if sample plants were collected at the end of a light period and at the end of a dark period within a 24-hour cycle of light and darkness and over 10 successive cycles. Under non-inducing conditions, GA_3 content increased during daylight and declined at the end of a subsequent dark period. This diurnal pattern was lost under inducing conditions when GA_3 levels were similar during a light period and the night period that followed.

Our data suggest that the biosynthesis of a tuber inducing stimulus may be a primary determinant of the rate of GA_3 biosynthesis during inducing conditions, and that the rate of GA_3 degradation is determined by the extent to which the stimulus accumulates during the day. It appears that the day-night cycle is composed of intricately balanced and interlaced positive and negative regulators of tuber induction.

References

[1]   Mander L. N. Twenty years of gibberellin research. *Nat. Prod. Rep*. **20**: 49-69 (2003).

[2]   Mander L. N. The chemistry of gibberellins: An overview. *Chem. Rev*. **92**: 573-612 (1992).

[3]   Kende H.; Zeevart J. A. D. The five classical plant hormones. *Plant Cell* **9**:1197-1210 (1997).

[4]   Malkawi A. A comparative analysis of gibberellic acid content with respect to tuber induction in potato plants grown under differential photoperiod and temperature. *Eur. J. Sci. Res*. **14**: 407-416 (2006).

[5]   Rodriguez-Falcon M; Bou J; Prat S. Seasonal control of tuberization in potato: Conserved elements with the flowering response. *Annu. Rev. Plant Biol*. **57**: 151-180 (2006).

[6]   Suarez-Lopez P. Long-range signaling in plant reproductive development. *Int. J. Dev. Biol*. **49:** 761-771 (2005).

[7]   Batutis E. J.; Ewing, E. E. Far-red reversal of red light effect during long-night induction of potato (*Solanum tuberosum* L.) tuberization. *Plant Physiol*. **69**: 672-674 (1982).

[8]   Amador V.; Bou J.; Martinez-Garcia J.; Monte E.; Rodriguez-Falcon M.; Russo E.; Prat S. Regulation of potato tuberization by daylength and gibberellins. *Int. J. Dev. Biol*. **45 (S1):** S37-S38 (2001).

[9]   Jackson S. D.; Prat S. Control of tuberization in potato by gibberellins and phytochrome *B. Physiol. Plant*. **98**:407-412 (1996).

[10]   Jackson S. D.; Heyer A.; Dietze J.; Prat S. Phytochrome B mediates the photoperiodic control of tuber formation in potato. *Plant J*. **9**: 159-166 (1996).

[11]   Jackson S. D.; James P. E.; Carrera E.; Prat S.; Thomas B. Regulation of transcript levels of potato gibberellin 20-oxidase gene by light and phytochrome B. *Plant Physiol*. **124**: 423-430 (2000).

[12]   Jackson S. D.; James P.; Prat S.; Thomas B. Phytochrome B affects the levels of a graft-transmissible signal involved in tuberization. *Plant Physiol*. **117**: 29-32 (1998).

[13]   Boccalandro H. E.; Ploschuk E. I.; Yanovsky M. J.; Sanchez R. A.; Gatz C.; Casal J. J. Increased phytochrome B alleviates density effects on tuber yield of field potato crops. *Plant Physiol*. **133**: 1539-1546 (2003).

[14]   Thiele A.; Herold M.; Lenk I.; Quail P. H.; Gatz C. Heterologous expression of Arabidopsis phytochrome B in transgenic potato influences photosynthetic performance and tuber development. *Plant Physiol*. **120**: 73-81 (1999).

[15]   Anderson G. R.; Jenner E. L.; Mumford F. E. Temperature and pH studies on phytochrome in *Vitro. Biochemistry* **8**: 1182-1187 (1969).

[16]   Burke M. J.; Pratt D. C.; Moscowitz A. Low-temperature absorption and circular dichroism studies of phytochrome. *Biochemistry* **11**: 4025-4031 (1972).

[17]   Quail P. H. Phytochrome photosensory signaling networks. *Nature Rev. Mol. Cell Biol*. **3**: 85-93 (2002).

[18]   Hunt R. E.; Pratt L. H. Physicochemical differences between the red- and the far-red-absorbing forms of phytochrome. *Biochemistry* **20**: 941-945 (1981).

[19]   Fodor S. P. A.; Lagarias J. C.; Mathies R. A. Resonance Raman analysis of the Pr and Pfr forms of phytochrome. *Biochemistry* **29**:11141-11146 (1990).

[20]   Ruddat A.; Schmidt P.; Gatz C.; Braslavsky S. E.; Gartner W.; Schaffner K. Recombinant type A and B phytochromes from potato. Transient absorption spectroscopy. *Biochemistry* **36**: 103-111 (1997).

[21]   Chory J. Light modulation of vegetative development. *Plant Cell* **9**: 1225-1234 (1997).

[22]   Briggs W. R.; Olney M. A. Photoreceptors in plant photomorphogenesis to date. Five phytochromes, two cryptochromes, one phototropin, and one superchrome. *Plant Physiol*. **125**: 85-88 (2001).

[23]   Pasternak R.; Wagniere G. Possible interpretation of long-wavelength spectral shifts in phytochrome Pr and Pfr forms. *J. Am. Chem. Soc*. **101**: 1662-1667 (1979).

[24]   Jackson S. D. Multiple signaling pathways control tuber induction in potato. *Plant Physiol*. **119**:
        1-8 (1999).
[25]   Xu X.; van Lammeren A. A. M.; Vermeer E.; Vreugdenhil D. The role of gibberellin, abscisic
        acid, and sucrose in the regulation of potato tuber formation *in vitro*. *Plant Physiol*. **117**: 575-
        584 (1998).
[26]   Koda Y.; Kikuta Y.; Tazaki H.; Tsujino Y.; Sakamura S.; Yoshihara T. Potato tuber inducing
        activities of jasmonic acid and related compounds. *Phytochemistry* **30**: 1435-1438 (1991).
[27]   Pelacho A. M.; Mingo-Castel A. M. Jasmonic acid induces tuberization of potato stolons
        cultured in vitro. *Plant Physiol*. **97**: 1253-1255 (1991).

Deformation of Concrete at Early Ages

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Abstract

The prediction of concrete properties at early ages depends on several factors, mainly the creep and shrinkage that occur inside the concrete during the hydration process. The development of strength (both in tension and compassion) has not been investigated due to lack of experimented data at early ages.

This paper presents the deformations for two concretes of different strength, first loaded at an age of one day. The load was increased in three steps and reduced in three steps over a period of five weeks. Shrinkage, creep and creep recovery strains are reported. Shrinkage and elastic strains are consistent with published data. Creep strains are largely irrecoverable and the irrecoverable creep develops mainly during the initial period under load. Deformation results are reported which show the effect of creep and shrinkage of concretes loaded at early ages. The results were also verified theoretically by a creep model which is also presented. The model is based on several assumptions that consider the properties of the concrete at early ages. Based on the experimental results, a relation between the creep coefficient and the concrete strength at 28 days was obtained.

Key words: Deformation, Concrete, Creep, Shrinkage

Introduction

This project was initiated in order to encourage the efficient use of early formwork removal of multi-stories floor slab construction. It was recognized that the interpretation of results of such construction would benefit from the knowledge of the deformation properties of the concrete used.

The reason why concrete creep has not yet been fully mapped out is that this phenomenon is extremely complicated. This is due the several factors that influence creep, such as age at loading (degree of hydration), loading time, concrete composition, temperature, moisture state and stress level.

In the present investigation the main interest has been devoted to the age-dependency of the creep and shrinkage due to loading and unloading at early age of concrete. This is required in order to parallel the pattern of loading and unloading due to early removal of formwork used for rapid construction in practice. To achieve this objective, an experimental program was established. Shrinkage, elastic strains, creep strains and creep recovery strains are determined for two concretes one with 28 day cube strength of 35 MPa and the other with a 28 day cube strength of 64 MPa.

Research Significance

The early age striking of floor slab formwork has been very common in recent years. This has been one response to reduce the construction time and the financial cost of the project. However, premature removal of formwork in concrete construction may result in dramatic failure. A number of concrete construction disasters have occurred as a result of premature formwork removal (Jaceb, 1974). To assure satisfactory performance and structural safety during construction due to early removal of formwork, a through understanding of the deformation of the concrete at early ages is necessary. The major factors are the creep and shrinkage strains that develop at early age of the concrete.

Experimental Program

Test specimens and curing conditions

Prisms measuring 100x100x280 mm were used for deformation tests and 100 mm cubes were used for compression strength tests. Two concretes of cube strength of 35 MPa and 64 MPa at 28 days were considered. The concrete mix proportions for the two concretes are shown in table 1. A 125mm long vibrating wire strain gauge was located centrally in each prism mould and three prisms were cast for each concrete mix. Twenty four cubes were cast for each mix. Half of the cubes were continuously water cured and the other half were dried in the laboratory after storage in their moulds for one day at 100 % relative humidity and 20ºc temperature. Pairs of the cubes were crushed at ages of 1, 3, 7, 14, 21 and 28 days for each curing condition.

   The prisms were partially sealed using a water proof, bituminous adhesive and a metal foil vapor barrier: Open areas, on two apposite faces, measuring 50x280mm were left unsealed. This gave a drying surface to volume ratio the same as that for a 200 mm thick slab (i.e. similar to that used in practice).

Table 1: concrete mix proportions (kg/m^3)

Components	28 day cube strengths	
	35 Mpa	**64 MPa**
5-10 mm Thames valley gravel (kg/m^3)	990	900
0-5 mm sand (kg/m^3)	820	720
Ordinary Portland cement (kg/m^3)	295	450
Water absorbed in aggregate (kg/m^3)	40	33
Free water (kg/m^3)	175	183

Tests

Two prisms from each concrete mix were loaded at an age of 1 day in a creep test. The stress histories for each concrete mix are shown in table 2. The remaining prism for each concrete mix served as a non-loaded control specimen: The resultant shrinkage strains were subtracted from the strains of the loaded prisms to yield the elastic plus creep strains.

   The deformation tests were conducted in an air conditioned laboratory at a temperature of 20 ± 1ºC and a relative humidity of 58 ± 2%. Strain readings were taken at time intervals that reflected the expected rate of strain: thus, for example, several readings were taken during the 24 hour period after a load change while readings were taken weakly during the period of creep recovery at the end of the tests.

Table 2: Stress histories for loaded prisms (MPa)

Age (days)	Concrete compression strength at 28 days	
	35 MPa	64 MPa
1 to 8	1.44	2.16
8 to 15	2.88	4.32
15 to 22	4.32	6.48
22 to 29	2.88	4.32
29 to 36	1.44	2.16
after 36	0	0

Loading Equipment and Strain Measurement
Creep Rig

The creep rig comprises a ram, four longitudinal reaction rods and an adjustable upper plate. The pressure is supplied to the ram under the control of a needle valve and is maintained by closure of the ram stop value. The ram load is calculated from the reading on a control gauge and the strains are measured using the vibrating wire strain gauges.

Strain Measurement

Strains are measured before and after the application of the compressive stress, so that an elastic strain and a creep factor (creep strain/elastic strain ratio) can be calculated. Normally, a constant stress is maintained for the duration of the creep test between two consecutive stresses as shown in table 2. Strains are also measured on non-loaded control specimens so that strains due to stresses can be isolated. Removal of stress causes elastic and creep recoveries which are also monitored.

Results
The shrinkage, elastic and creep strains for each concrete mix are shown in figures 1 and 2. The elastic plus creep strains are the average values for the two loaded prisms; the strain differences between the pairs of prisms were typically 5 to 15 ηstrain (i.e. less than 4% of the maximum strain measured). The resolution of the strain measuring equipment was around 1 ηstrain and successive readings on the non-loaded control specimens exhibited a variation of less than ±3 ηstrain about a smooth trend line. Figures 1 and 2 indicate that the shrinkage strains after 60 days were comparable in magnitude to the irrecoverable creep strains. After each change of load an immediate elastic strain was observed and this was followed by a creep or creep recovery strain

Figure 1: Strain versus time after first loading (35 MPa concrete, specimens 1,2 and 3)
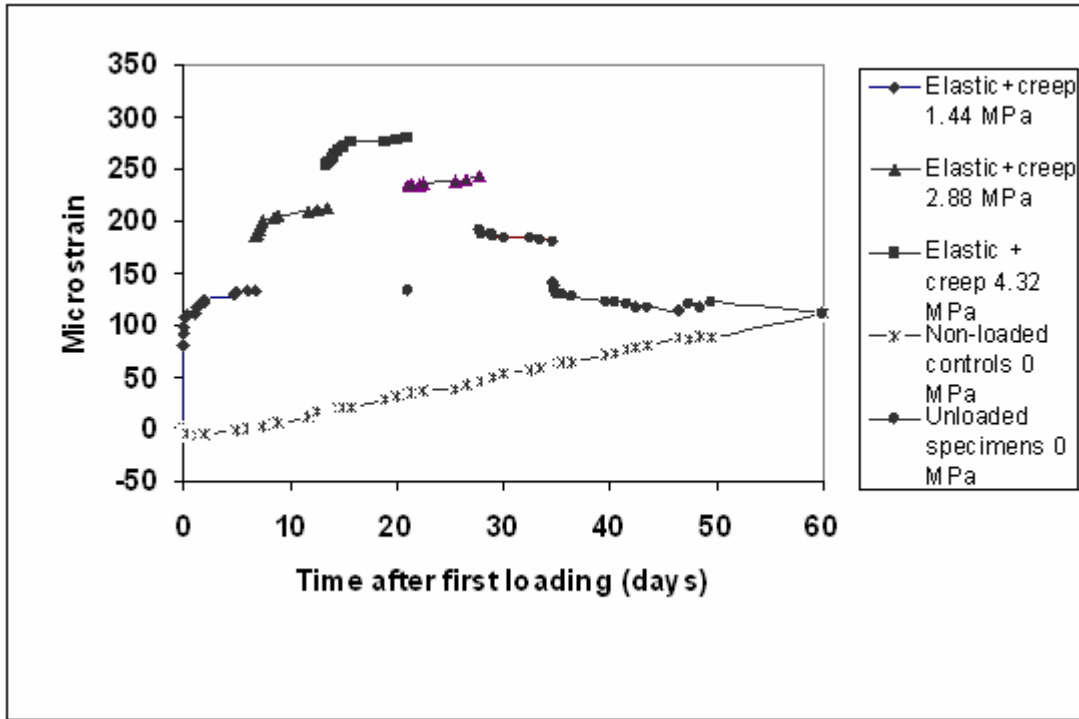
Figure 2: Strain versus time after first loading (64 MP a concrete, specimens 4,5 and 6)
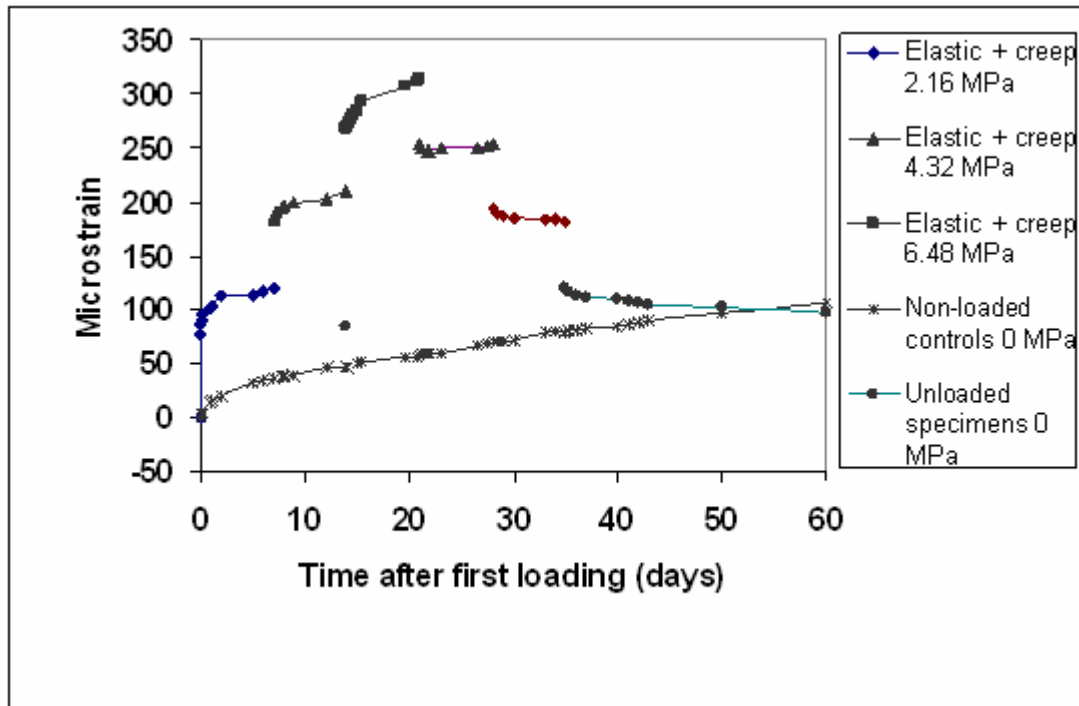
that rapidly declined in rate of development. Prisms were unloaded temporarily after 14 or 21 days (for 0.01 days) to obtain some idea of the rate at which irrecoverable creep developed. The results indicate that irrecoverable creep develops most strongly during the initial two week period under increasing load. Some selected values of elastic, total load induced, creep and shrinkage strains are given in table 3 together with the corresponding elastic moduli. The elastic strains and elastic moduli values are derived from the strain changes 0.01 days after a load change and from the change of stress. The total

strains due to load are the sum of elastic irrecoverable and recoverable creep strains. The elastic modulus increases up to an age of one or two weeks but thereafter the changes are small. The initial rate of shrinkage for the 64 MPa concrete mixes was greater than that for the 35 MPa concrete mixes but after 60 days the shrinkage strains for the two mixes were approximately similar.

Table 3: Selected deformation results

f_{cu} (Mpa)	Age (days)	1	8		15			22			29		36		43		60
	Stress (MPa)	1.44	1.44	2.88	2.88	4.32		4.32	0	2.88	2.88	1.44	1.44	0	0	0	0
	ε_{el} (ηstrain)	92	92	149	149	195		195	47	149	149	98	98	48	48	48	48
	ε_{tot} (ηstrain)	92	140	197	233	279		315	167	269	291	240	244	164	202	202	211
35	ε_{sk} (ηstrain)	0	5	5	17	17		31	31	31	46	46	61	61	81	81	105
	ε_{li} (ηstrain)	92	135	192	216	262		284	136	238	245	194	183	133	121	121	106
	ε_{cr} (ηstrain)	0	43	43	67	67		89	89	89	96	96	85	85	73	73	58
	Creep factor	-	0.467		0.450			0.456			-0		-		-		-
	E_m (GPa)	15.7	25.4		31.3			29.2			28.2		28.8		-		-
	E_p (GPa)	14.7	24.1		27.6			27.1			28.8		-		-		-
	Stress (MPa)	2.16	2.16	4.32	4.32	0	6.48	6.48	4.32		4.32	2.16	2.16	0	0	0	0
	ε_{el} (ηstrain)	87	87	151	151	24	213	213	152		152	90	90	26	26	26	26
	ε_{tot} (ηstrain)	87	159	223	262	135	324	379	318		331	269	267	203	200	200	214
64	ε_{sk} (ηstrain)	0	37	37	48	48	48	60	60		71	71	81	81	91	91	109
	ε_{li} (ηstrain)	87	122	186	214	87	276	319	258		260	198	186	122	109	109	105
	ε_{cr} (ηstrain)	0	35	35	63	63	63	106	106		108	108	96	96	83	83	79
	Creep factor	-	0.402		0.417			0.497			-		-		-		-
	E_m (GPa)	24.3	33.8		34.0			35.4			34.8		33.8		-		-
	E_p (GPa)	21.9	31.9		33.7			35.5			36		-		-		-
Ratio of load-induced strains for the two mixes		1.06	1.11		1.01			0.89			0.95		0.98		1.11		1.01

ε_{el} = Elastic strain; ε_{tot} = total strain; ε_{sk} = Shrinkage strain; ε_{li} = Load-induced strain; ε_{cr} = Creep strain;
E_m = Measured elastic modulus; E_p = Predicted elastic modulus

Table 4 shows the average compressive strength for pairs of cubes for both continuously water cured specimens and dried specimens after an age of half day.

Table 4: Compressive strengths for water cured and air dried 100 mm cubes

Age (days)		0.5	1	3	7	14	21	28
35 Mpa	Water	-	6.8	17.6	26.9	31.5	33.6	35.0
	air	-	6.7	15.6	22.8	27.8	28.0	28.7
64 Mpa	Water	6.7	23.0	41.8	54.0	57.5	63.0	64.0
	Air	5.5	20.0	35.5	42.0	47.0	51.4	52.0

Discussions
Shrinkage

The shrinkage strains for the two concrete mixes developed at different rates initially. The high initial rate for the 64 MPa concrete was probably due to a process of internal drying where cement hydration consumes water from a relatively small capillary pore volume. The free water/cement ratios for the 35 and 64 MPa concretes were 0.60 and 0.41 respectively, and such a difference is known to produce a difference in the level of self-desiccation (Copeland and Bragg, 1955). Longer-term shrinkage is due to evaporation from the non-sealed regions of the prism surface. The shrinkage strains of about 105 ηstrain after 60 days are comparable with the six month shrinkage value of 140 ηstrain predicted from references (Parrott, 1979, and British Standard BS8110, 1985).

Elastic strain

The elastic moduli values in table 3 exhibit an increase with age that reflect continued hydration of the cement; parallel changes of compressive strength can be observed in Table 4. The change of strength, f_{cu} (MPa) can be used to predict the age dependence of the elastic modulus, E_c (GPa) using an equation given in reference 3.

$$E_c = E_{28} (0.4 + 0.6 \frac{f_{cu(t)}}{f_{cu(28)}}) \tag{1}$$

The predicted values of elastic modulus are shown in table 3. They are mostly within 2 GPa of the measured values. It was also suggested (Parrott, 1979) an equation of the 28 day elastic modulus as:

$$E_{28} = C_o + 0.2 \, f_{cu(28)} \tag{2}$$

Where C_o is a constant that depends on the aggregate type. The values of C_o for the 35 and 64 MPa concrete mixes (based on the experimental results) were 21.4 and 22.7 GPa, respectively. The difference between these values is insignificant and an average value of 22 GPa was considered which is well within the range of values given in reference (Parrott, 1979).

Creep

The total load-induced strains for the two concrete mixes show similar patterns of development with time in table 3, although the absolute levels of stress and deformation were different. The ratios of the load-induced strains at a given age for the two concrete mixes are approximately constant and are fairly close to unity (table 3). This result is not too surprising because the load patterns and the elastic strains for the two concrete mixes were comparable. Thus in broad terms the recoverable and irrecoverable components of creep could be treated as proportional to the elastic strains without great error. The ratio of the creep strain to the recoverable elastic strain varied between 0.402 and 0.497 before decreasing the stress as shown in table 3.

Selected creep recovery strains, after unloading at an age of 36 days are shown in table 5. The recoverable creep strains are extremely small and the rate at which they develop is fast enough to justify adding the 60 day value to the elastic strain and assuming instantaneous formation of both components.

Table 5: Recoverable creep strains after unloading

Concrete Strengths	Elastic strain at 36d (η strain)	Recoverable creep (ηstrain) at		
		36d	43d	60d
35 MPa	48	9	21	36
64 MPa	26	12	25	29

Irrecoverable creep probably arises in part from the local, temporary relief of stress on the cement particles as they hydrate under load (British Standard BS8110, 1985). A further contribution to irrecoverable strains derives from incomplete recovery of the elastic strains: The sum of the elastic strains during the steps of decreasing load is smaller than the sum for increasing load. Presumably the elastically deformed components in the cement paste phase of the concrete are unable to recover fully due to restraint from new hydration products.

Creep Model

The present investigation has mainly studied the age dependency of creep at early ages. None of the methods in use today takes the marked age dependency which occurs at early age into consideration. The following assumptions are considered in the model:

1. The deformation of all micro-elements is the same and is equal to the total deformation, ϵ_{tot}.

2. The properties of the newly formed cement gel are independent of the age and are newly formed in a stress-free state. If the external load remains unchanged over a period of time, the newly formed gel remains in a stress-free state.
3. The mean length of migration passage λ is mainly dependent on the age at time of loading t_o.
4. The gel growth takes place in smaller and smaller pores as the age increases. The pore size is reduced drastically when a high age has been reached.

An expression for the creep function, J_{tot}, can be derived based on the above assumptions. The following is true within each volume unit of cement gel:

$$\in_{tot(t)} - \in_{sh^{9t)}} = \int_0^t J_g(t,t_o).\frac{\partial \delta_g(t_o)}{\partial t_o} dt_o \tag{3}$$

Where: $\in_{tot}$ = Total deformation
$\in_{sh}$ = Load independent deformation due to shrinkage
$J_g(t, t_o)$ = creep function of the cement gel.
σ_g = stress in the cement gel
t_o = Age of concrete at time of loading
t = Relevant time.

However, a change of the external stress at time t_o will affect the entire gel volume $V(t_o)$, i.e.

$$\frac{\partial \sigma(t_o)}{\partial t_o} = v(t_o)\frac{\partial \sigma_g(t_o)}{\partial(t_o)} \tag{4}$$

since the cement gel has the same proportions at all concrete ages, its creep should only be affected by the mean length of migration passage at the time of loading, $\lambda(t_o)$. This leads to the following expression for $J_g(t, t_o)$ which is given by Bazant (Bazant, 1977):

$$J_g(t, t_o) = \frac{1}{E_g} + \frac{F_g(t-t_o)}{\lambda^2(t_o)} = \tag{5}$$

Where: E_g = elastic modulus of the micro-element of the cement gel.
λ = Mean length of passage for diffused particles caused by loading.
F_g = theoretical creep function for an individual micro-element at constant λ, and depends only on the loading time, $(t-t_o)$.

Inserting equations (4) and (5) into (3) loads to:

$$\in_{tot} - \in_{sh}(t) = \int_o^t J_{tot}(t, t_o).\frac{\partial \sigma(t_o)}{\partial t_o} dt_o \tag{6}$$

Where: $J_{tot}(t, t_o)$ is a creep function, represents the deformation at time t due to a unit stress acting from time t_o and given by:

$$J_{tot}(t, t_o) = \frac{1}{E_g.V(t_o)} + \frac{F_g(t,t_o)}{V(t_o).\lambda^2(t_o)} \tag{7}$$

The concrete creep can also be described by mean of the creep coefficient $\varphi(t, t_o)$ which is a measure of the additional deformation caused by creep:

$$(t, t_o) = \frac{\in_c(t,t_o)}{\in_E(t_o)} \tag{8}$$

Where $\in_c(t, t_o)$ = creep deformation
$\in_E(t_o)$ = Instantaneous deformation

The value of $\varphi(t, t_o)$ depends on the composition of the concrete, the age at the time of loading and the loading time. The influence of these factors can be taken into account by giving the creep coefficient a basic value φ_o which depends on the concrete composition. This value is then modified by correction factors which consider the effect of the loading age, φ_{to}, and the loading time $\varphi_{(t-to):}$:

$$\varphi(t, t_o) = \varphi_o, \varphi_{(t-to)}. \varphi_{to} \tag{9}$$

The effect of the loading age in relation to loading at 28 days can be obtained by inserting equation (7) in equation (8) that leads to:

$$\varphi(t,t_o) = \frac{E_g . F_g(t,t_o)}{l^2(t_o)} \tag{10}$$

For constant loading time, t-t_o, $F_g(t$-$t_o)$ is constant. The correction factor for the influence of the age at the time of loading is:

$$\varphi_{to} = \frac{\varphi(t,t_o)}{\varphi(t,t = 28d)} \tag{11}$$

Then insert equation (10) into equation (11) leads to:

$$\varphi_{to} = \frac{l^2(t_o = 28d)}{l^2(t_o)} \tag{12}$$

The mean migration length, l, depends on the gel volume. According to Bergstram (Bergstram, 1967), the gel volume is given by:

Gel volume $= 0.51. \alpha. C$ \hfill (13)

Where α is the degree of hydration

        C is the cement content

Previous investigation (Bergstram, 1967) showed that the mean migration length is proportional to the gel volume of the form:

$l(t_o) = k \, (\text{gel volume})^{1/3} = k' \, \alpha^{1/3}$

Substitute into equation (12) leads to:

$$\varphi_{to} = \left(\frac{\alpha}{\alpha^{28d}}\right)^{-2/3} \tag{14}$$

The above expression can be expressed as a function of $\dfrac{f_c}{f_c^{28d}}$ by assuming a linear relation between α and f_c. This leads to:

$$\varphi_{t0} = \left[\frac{\dfrac{f_c}{f_c^{28d}} + a}{1 + a}\right]^{-2/3} \tag{15}$$

Where a is a coefficient which depends on the w/c ratio and determined experimentally and equal to 0.17 for the present case

Figure 3 presents $\varphi$to as a function of the strength at 28 days, $\dfrac{f_c}{f_c^{28d}}$ based on the experimental results.

Figure 3: Age dependence of the coefficient of creep.
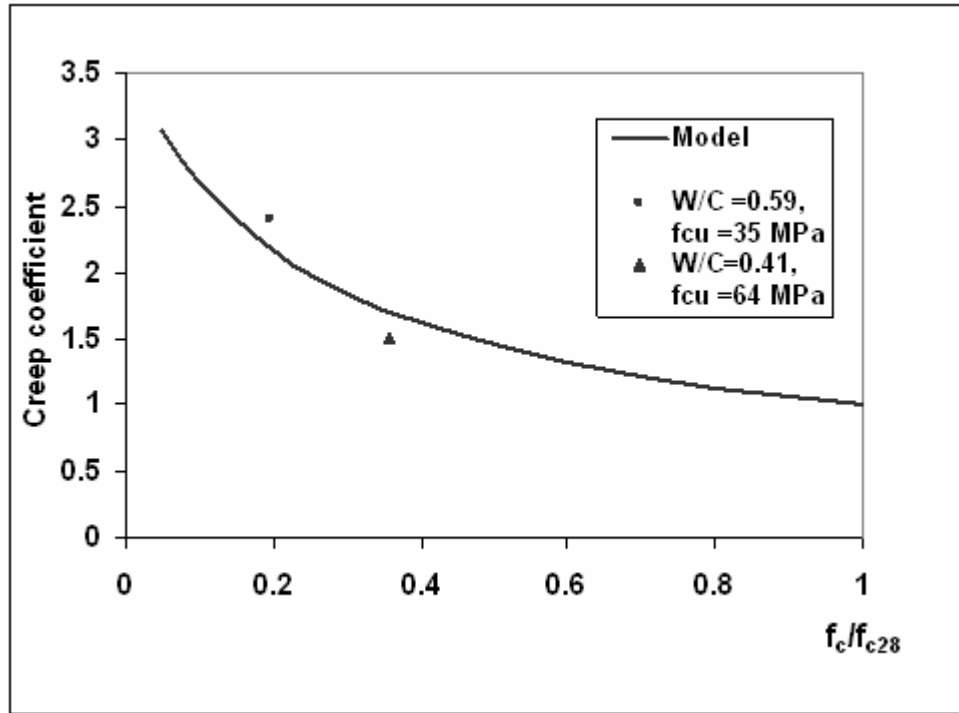
Conclusions

The measured elastic and shrinkage strains were consistent with those expected from published data. The creep strains were largely irrecoverable and the major portion of irrecoverable creep appeared to develop during the first two weeks under load. The test results suggest that creep deformation could, for analytical purposes, be treated as proportional to elastic strains. A relation between the creep coefficient and the concrete strength at 28 days was obtained which compares reasonably well with the experimental results.

Acknowledgement

References

[1]   Feld, Jaceb, "Reshoring of multistory concrete buildings" Concrete construction V.19, No. 5, May 1974, pp. 213-248.

[2]   L. Copeland and R. Bragg. "Self-desiccation in Portland-cement pastes", ASTM Bulletin, February 1955, 34-39

[3]   L.J. Parrott, "Simplified methods of predicting the deformation of structural concrete". C & CA development Report No. 3, October 1979, 11 pages.

[4]   British Standards Institute, Structural use of concrete, BS 8110: Part 2: 1985.

[5]   RILEM committee 42-GEA, Properties of set concrete at early age-state-of-the-art report, Materials and Structures, Vol. 14, No. 84, 399-450.

[6]   Bergstrom et al, Byggnadsmateriallara, FK I, Lunds Institute of technology, VSV, 1967, Lund.

[7]   Bazant Z. P, Viscoleasticity of solidifying porous material-concrete. Swedish Cement and Concrete Research Institute, Fo 5:77, 1977, Stockholm.

Effect of Wrapping Columns with FRP Laminates

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Abstract

This paper presents the experimental study conducted to examine the effect of wrapping columns with fiber reinforced polymers (FRP) laminates. Two types of fiber wraps were used, namely glass (GFRP) and carbon (CFRP) fiber laminates. Test specimens consisted of twelve full-scale reinforced concrete columns subjected to concentric axial loads up to failure. To examine the effect of columns dimensions on the added confinement due to wrapping, two configurations were used namely 200x200x2440 mm and 200x300x2440 mm specimens. For each configuration, two bare specimens, two specimens wrapped with GFRP laminates and two specimens wrapped with CFRP laminates were tested. The study concluded that FRP wrapping had a favorable effect either in terms of increasing the carrying capacity of columns as well as the ductile type of mode of failure contrary to bare columns specimens whose failure was sudden. Both types of wraps gave very similar confinement effects.

Introduction

The effect of wrapping reinforced concrete columns with fiber reinforced polymers (FRP) laminates has been experimentally investigated in several studies [1,2]. The specimens examined in these studies were essentially short columns with very low slenderness ratio in the range of 2 to 4. Such values are far less than those of actual columns in typical buildings constructions. Hence, the findings of such cases should be interpreted accordingly. The main concern is the reported modes of failure might not very well be materialized in actual applications. To overcome this shortcoming, the present study conducted experimental investigation using full-scale columns wrapped with FRP laminates. Using such realistic and more representative specimens, the study examined the effects of columns section aspect ratio and the type of composite wrap used, namely glass and carbon fibers composites, on the performance and axial compressive strength of wrapped columns.

Composite Materials

Two types of fiber reinforced polymer (FRP) wraps were used in the present study, namely:

1. TYFO® SEH-51A Composite System [Glass FRP (GFRP)]. It is a custom weave, unidirectional glass fabric. The glass material is oriented in the 0° direction with additional yellow glass cross fibers at 90°. The system properties are listed in Table 1.

Table 1: TYFO SEH-51A Composite Laminate Properties.

Property	ASTM Method	Typical Test Value	Design Value
Ultimate tensile strength in primary fiber direction	D-3039	575 MPa	460 MPa
Elongation at break	D-3039	2.2%	2.2%
Tensile Modulus	D-3039	26.1 GPa	20.9 GPa
Ultimate tensile strength 90 degrees to primary fiber	D-3039	25.8 MPa	20.7 MPa
Laminate Thickness		1.3 mm	1.3 mm

2. TYFO® SCH-41S [Carbon FRP (CFRP)]. It is a unidirectional carbon fabric with aramid cross fibers. It has been custom stitched, with the carbon material oriented in the 0° direction, and the aramid fibers at 90°. The system properties are summarized in Table 2.

Table 2: TYFO SCH-41S Composite Laminate Properties.

Property	ASTM Method	Typical Test Value	Design Value
Ultimate tensile strength in primary fiber direction	D-3039	876 MPa	745 MPa
Elongation at break	D-3039	1.2%	1.2%
Tensile Modulus	D-3039	72.4 GPa	61.5 GPa
Ultimate tensile strength 90 degrees to primary fiber, psi	D-3039	40.6 MPa	34.5 MPa
Laminate Thickness		1.0 mm	1.0 mm

Columns Testing

Test Specimens

To determine the effect of FRP wraps on column strength, a total of six square columns of dimensions 200x200x2440 mm and six rectangular columns of dimensions 200x300x2440 mm, were tested under axial loads. Reinforcement details are given in Table 3. For each geometry, square or rectangular, two specimens were bare columns, two specimens were carbon-fiber wrapped columns, and two specimens were glass-fiber wrapped columns, as listed in Table 3.

Table 3: Details of Column Specimens.

Column Dimensions (mm)	Reinforcement		Number of Control Specimens (Bare)	Number of Specimens with CFRP Wraps	Number of Specimens with GFRP Wraps
	Longitudinal	Stirrups/m			
2440x200x200	4Ø12	5Ø8	2	2	2
2440x200x300	4Ø12	5Ø8	2	2	2

Testing Procedures

The Columns Specimens were axially loaded using a load-controlled compression testing machine. Test setup is shown in Fig. 1. Loading rate was monitored during testing to maintain reasonable rate throughout, namely higher rates at early stages and lower rates at later stages of testing. For each specimen, ultimate load was recorded and the mode of failure was observed

Figure 1: Test setup for columns.

a. Testing frame.   b. Loading setup.

Test Observations

Bare Specimens. C1 (200x200mm): Failure was sudden as crushing of concrete occurred at the top of the column as shown in Fig. 2. Peak load of 703.4 kN was recorded.

Figure 2: Failure pattern of specimen C1 (bare – 200x200 mm).
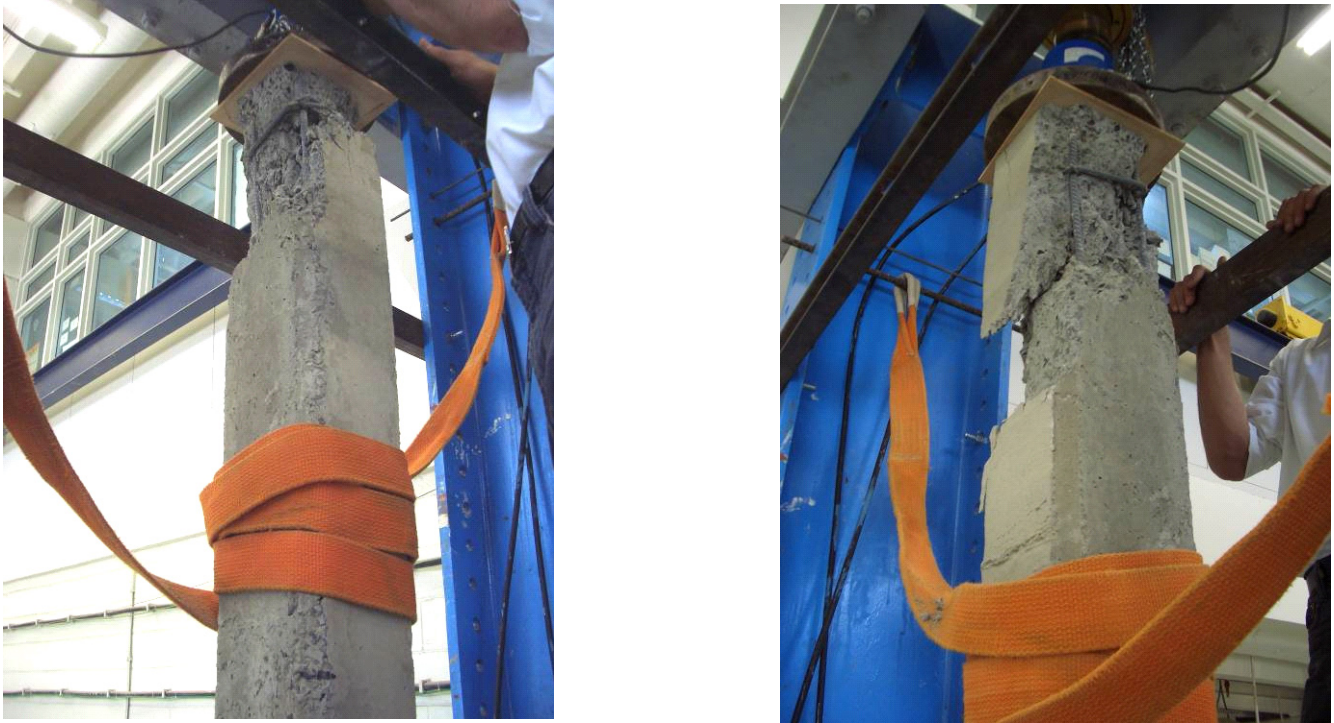
C2 (200x200 mm): Same failure as for C1 except it occurred at the bottom of the column. A lower peak load of 620.7 kN was recorded.

C3 (200x300 mm): Failure was sudden and the mode of failure was characterized by crushing of concrete and buckling of longitudinal rebars at the bottom of the column (Fig. 3). A peak load of 1042.5 kN was recorded.

Figure 3: Failure pattern of specimen C3 (bare – 200x300 mm).

C4 (200x300 mm): Sudden failure occurred by crushing of concrete and substantial buckling of longitudinal rebars at mid-height of the column (Fig. 4). Vertical cracks appeared at the lower end of the column. A lower peak load of 878 kN, as compared to that of C3, was recorded.

Figure 4: Failure pattern of specimen C4 (bare – 200x300 mm).

Carbon Fiber Wrapped Specimens. C5 (200x200 mm): No sudden failure was observed but rather a ductile made of failure manifested by the increasing lateral deflection at column mid-height (Fig. 5). As a result, ripples at wrap surface were observed. Testing was terminated after reaching peak load and remained constant. It is interesting to note that after completing the test, column specimen was sawed to expose and examine the concrete core, as shown in Fig. 6. It can be seen that the concrete column suffered extensive cracking and disintegration and yet no crushing failure occurred due to the confinement induced by the wrapping. A peak load of 996 kN was recorded, which is higher than that for bare columns by as much as 15%. This shows the favorable contribution of wrapping to the carrying capacity of columns.

Figure 5: Failure pattern of specimen C5 (CFRP – 200x200 mm).

Figure 6: Exposed concrete core of specimen C5.
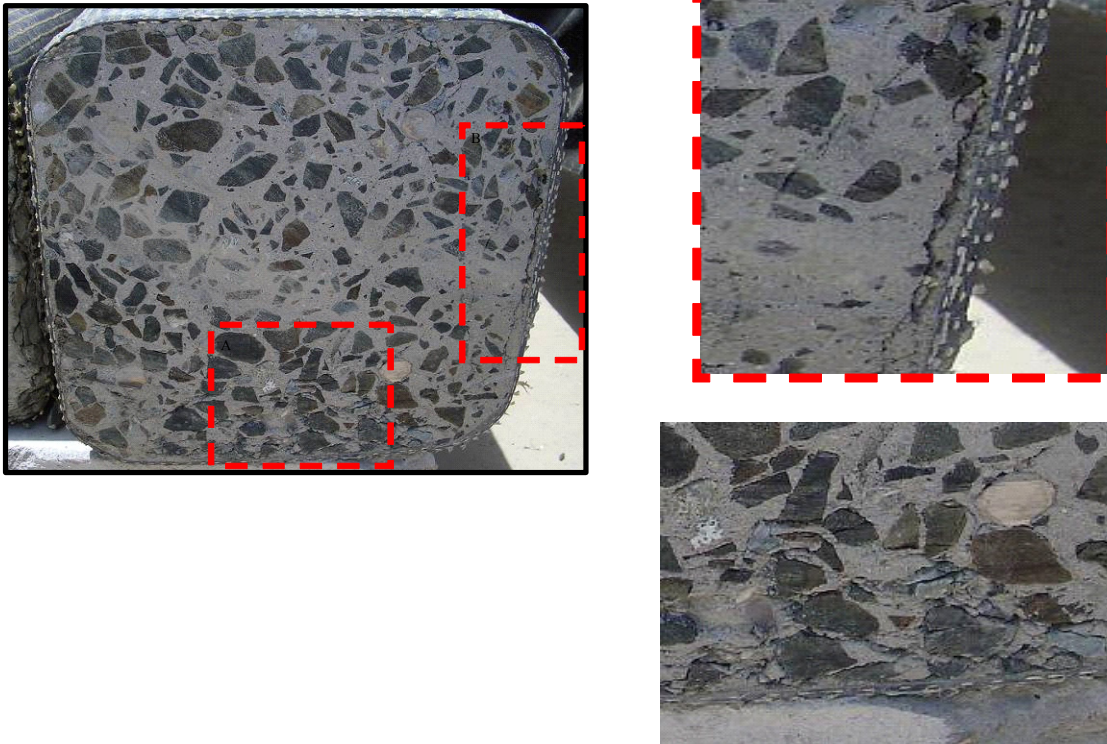
C6 (200x300 mm): No sudden failure took place but testing was terminated due to poling off of wrapping (Fig. 7) apparently due to imperfections of wrap application. A some what lower peak load was recorded as 930 kN.

Figure 7: Imperfection of wrap application of specimen C6 (CFRP – 200x300 mm).

C7 (200x300 mm): Similar behavior to specimen C5 was observed. Buckling of S-type of column was observed as shown in Fig. 8. A peak load of 1181 kN was recorded

Figure 8: Failure pattern of specimen C7 (CFRP – 200x300 mm).

C8 (200x300 mm): Similar behavior to specimen C5 was observed. A peak load of 1233 kN was recorded.

Glass Fiber Wrapped Specimens. C9 (200x200 mm): No sudden failure, and buckling mode was observed with increasing lateral deflection at column mid-height (Fig. 9). Ripples formed along the height and debonding increased as testing proceeded, accompanied by crackling sounds. Peak load of 1060 kN was recorded .

Figure 9: Failure pattern of specimen C9 (GFRP – 200x200 mm).
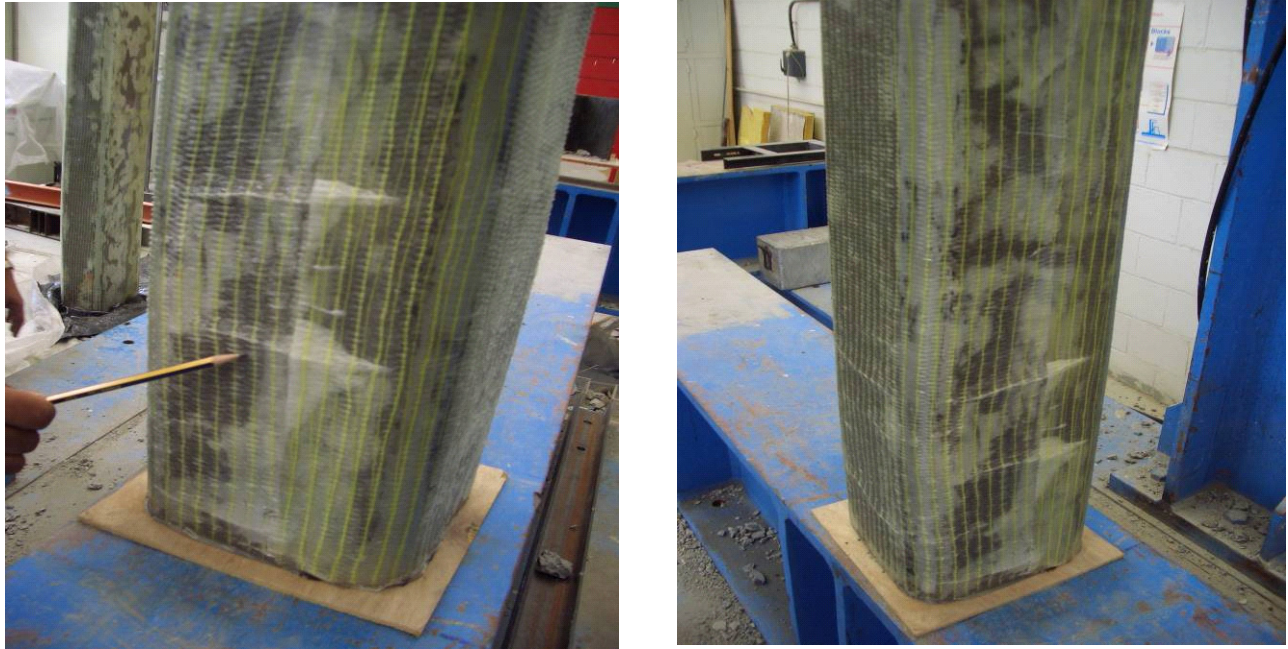
C10 (200x200 mm): Similar behavior to specimen C9 was observed (Fig. 10) and almost identical peak load of 1055 kN was recorded.

Figure 10: Failure pattern of specimen C10 (GFRP – 200x200 mm).

C11 (200x300 mm): Failure was not sudden and minor lateral deflection was observed at column mid-height (Fig. 11). A peak load of 1174 kN was recorded.

Figure 11: Failure pattern of specimen C11 (GFRP – 200x300 mm).

C12 (200x300 mm): Failure was not sudden and crackling sound indicating debonding of wrapping was observed (Fig. 12). A peak load of 1180 kN was recorded.

Figure 12: Failure pattern of specimen C12 (GFRP – 200x300 mm).

Test results of the column specimens are summarized in Table 4. Presented in the last column of Table 4 is the ultimate load of wrapped columns calculated as per available formulae in the literature [3,4]. A reasonable agreement can be observed between experimental and theoretical values of ultimate axial loads.

Table 4: Summary of Columns Testing Results.

Type	Specimen			Failure		Pult (experimental) (kN)	Pult (theoretical) (kN)
	No.	Size (mm)		Type	Modes		
Bare Columns	C1	200	200	Sudden	Crushing+ of concrete	703	760
	C2	200	200	Sudden	Crushing of concrete	621	760
	C3	200	300	Sudden	Crushing + Rebar buckling	1042	1050
	C4	200	300	Sudden	Crushing + Rebar buckling	878	1050
CFRP Wrapped Colums	C5	200	200	Not sudden	Column buckling	996	905
	C6	200	200	Not sudden	Wrap peeling off	931	905
	C7	200	300	Not sudden	Lateral deflection	1181	1230
	C8	200	300	Not sudden	Column buckling + debonding of wrap	1233	1230
GFRP Wrapped Columns	C9	200	200	Not sudden	Column buckling + debonding of wrap	1060	828
	C10	200	200	Not sudden	Column buckling + debonding of wrap	1055	828
	C11	200	300	Not sudden	Minor column buckling + debonding of wrap	1174	1136
	C12	200	300	Not sudden	Minor column buckling + debonding of wrap	1180	1136

Conclusions

1. The reported study used full-scale column specimens which are believed to be more representative of actual applications of wrapped columns as compared to previous studies.

2. Wrapping has a definite effect of increasing the ultimate axial load of columns with square cross sections, and to a lesser extent for cases of rectangular sections.
3. All wrapped columns invariably showed favorable modes of failure which were not sudden and with ample warning symptoms.
4. Carbon and glass fiber laminates showed very similar effects in terms of the added axial strength of tested columns specimens.

References

[1]   Esfahani, M.R. and Kianoush, M.R., "Axial compressive strength of reinforced concrete columns wrapped with FRP", Proceedings, 1st Conference on Application of FRP Composites in Construction and Rehabilitation of Structures, Tehran, Iran, May 4, 2004, pp 51-60.

[2]   Mandal, S. and Fam, A., "Axial loading tests on FRP confined concrete of different compressive strengths," Proceedings, 4th Advanced Composite Materials in Bridges and Structures, Calgary, Alberta, Canada, July 20-23, 2004.

[3]   ACI Committee 440, "Guide for the design and construction of externally bonded FRP systems for strengthening of concrete structures," Technical committee document 440.2R-02, 2002.

[4]   Theriault, M. and Neale, K.W., "Design equation for axially loaded reinforced concrete column strengthened with FRP wraps," Canadian Journal of Civil Engineering, Vol. 27, 2000, pp. 1011-1020.

Swarm Intelligence: A New Approach to Solving Critical Organizational Challenges in the Complex Future Business Environment

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Abstract

In the age of globalization, we are constantly confronted with volatile balances in the political, economic and social sphere. But the more and more complex world is not only a threat. It also offers great opportunities to those who face up to the challenge with complex dynamic approaches based on the ideas of self-organization. Blueprints of these approaches can be found in atomic physical systems, molecular biological systems, as well as, ecological systems and neuronal networks. Swarm Intelligence uses findings based on the social behavior of swarm animals such as ants, bees, fish and birds to develop answers to challenges faced in today's complex business environment. Swarm Intelligence (SI) encompasses various approaches to challenges in different fields of application. This paper provides a set of general principles for SI research, development and applications.

Introduction

Swarm Intelligence (SI) is a relatively new paradigm being applied in a host of research settings to improve the management and control of large numbers of interacting entities, like communication, computer and sensor networks, satellite constellations and more. Attempts to take advantage of this paradigm and mimic the behavior of insect swarms however often lead to many different implementations of SI. The rather vague notions of what constitutes self-organized behavior lead to rather *ad hoc* approaches that make it difficult to ascertain just what SI is, assess its true potential and more fully take advantage of it. A precise definition of *self-organized* behavior is described and provides the basis for a more axiomatic and logical approach to research and development as opposed to the more prevalent *ad hoc* approach in using SI concepts (Fleischer M., 2003).

Today's communications and business networks have become enormously complex systems. New technologies from sensor networks, web-enabled PDAs, remote surgery systems to constellations

of orbiting satellites all require enormous numbers of communicating and interacting entities. These entities must work together harmoniously to be effective. As the numbers of these interacting entities increases, ensuring their efficient operation becomes increasingly difficult. Indeed, for the past three decades this growth in general has approximately doubled every 18 months (Leon-Garcia and Widjaja, 2000 p.32). New paradigms of modern warfare, also, indicate an accelerated growth in the numbers of interacting systems. Amidst this growth, there is a growing consensus among experts that current network management approaches will be insufficient to handle the level of complexity that is envisioned. Consequently, new approaches for network management and control in complex systems are needed.

One promising approach is based on what is often referred to as *Swarm Intelligence* (SI). The term SI has come to represent the idea that it is possible to control and manage complex systems of interacting entities even though the interactions between and among the entities being controlled is, in some sense, minimal (Arquilla and Ronfeldt, 2000). This notion therefore lends itself to forms of distributed control that may be much more efficient, scalable and effective for large, complex systems. The underlying features of SI are based on observations of social insects. Ant colonies and beehives, for example, have the interesting property that large numbers of them seem to conduct their affairs in a very organized way with seemingly purposeful behavior that enhances their collective survival.

Surprisingly and paradoxically, these insects seem to utilize very simple rules of interaction. This phenomenon is very similar to those addressed in other domains of inquiry involving *complexity*, like cellular automata and the study of chaos (Prigogine and Stengerrs, 1984). These areas along with SI have perplexed a large number of scientists for many years (Poundstone, 1985). How is it that "swarms" of creatures with relatively low brain power and communications capabilities can engage is what is often termed "emergent behavior" reflective of some "collective intelligence" (Bonabeau et al., 1999, p.6) behavior that seems to exhibit a more global purpose?

Unfortunately, there is no widely agreed upon definition of what SI is or how it should or could be mathematically defined or characterized. Many terms have been associated with SI, such as *emergent behavior, self-organized behavior, collective intelligence*, and the like and have been used in a variety of contexts and associated with a host of applications (Bullnheimer et al., 1997, Maniezzo et al., 1994, Schoonderwoerd et al., 1996); these terms also suffer from vague definitions or descriptions. There is no general, mathematically oriented description that ties all of these concepts together.

The lack of precise definitions and theoretical foundations, poses a number of significant problems and confusion. The lack of precise definitions is the least of the problems; this confusion, also, entails missed opportunities. All these different descriptions and implementations muddy the waters of how to productively utilize SI concepts. Without a clear understanding of what SI is and how and why it arises, it is very difficult to envision how to take advantage of its true potential. The remedy for this apparent confusion comes from new perspectives that illuminate the *fundamental* properties of SI. This paper seeks to do just that by articulating some useful ideas based on perspectives from evolution, notions of efficiency and adaptability coupled with a more formal definition of self-organized behavior.

The Swarm Intelligence Paradigm
A. Observations of Social Insects

Observations of social insects, like ants and ant colonies provide a great deal of insight into their behavior and SI in general. Ants and ant colonies have several ways of solving different but related problems. The main mechanism for solving them is through the use of chemical substances known as *pheromones* which have a scent that decays over time through the process of evaporation (Bonabeau et al., 1999, p.6). These pheromones form the basis of what amounts to a clever, and apparently simple, communications and information storage and retrieval system.

Since pheromone strength or intensity decays over time, it also provides a very simple information processing mechanism that can implement forms of positive and negative feedback (Merkle and Middendorf, 2002a) and *reinforcement learning* mechanisms (Semet et al., 2003, Sutton and Barto, 1998). This "processing" capability is illustrated in the simplicity of how ants utilize and respond to pheromones. As an example, consider how ants actually solve shortest path problems. Their motivation for solving these problems stems from their need to find sources of food. Efficiency dictates that they find sources closest to their colonies. Ants (many ants) first set out in search of a food source by randomly choosing (apparently randomly) several different paths. Along the way they leave traces of pheromone (Bonabeau et al., 1999).

Once ants find a food source, they retrace their path back to their colony (and in so doing inform other ants in the colony) by following their scent back to their point of origin. Since many ants go out from their colony in search of food, the ants that return first are presumably those that have found the food source closest to the colony or at least have found a source that is in some sense more accessible. In this way, an ant colony can identify the shortest or "best" path to the food source. The cleverness and simplicity (Toffler, 1991) of this scheme is highlighted when this process is examined from what one could conceive of as the ants' perspective; they simply follow the path with the strongest scent (or so it seems). The shortest path will have the strongest scent because less time has elapsed between when the ants set out in search of food and when they arrive back at the colony, hence there is less time for the pheromone to evaporate. This leads more ants to go along this path further strengthening the pheromone trail and thereby reinforcing the shortest path to the food source and so exhibits a form of reinforcement learning (Kalbling et al., 1996, Littman and Boyan, 1993). But this simple method of reinforcement or positive feedback also exhibits important characteristics of efficient group behavior. If, for instance, the shortest path is somehow obstructed, then the second best shortest path will, at some later point in time, have the strongest pheromone; hence will induce ants to traverse it thereby strengthening this alternate path.

Thus, the decay in the pheromone level leads to *redundancy, robustness and adaptivity, i.e.,* what some describe as *emergent* behavior (Bowyer and Bogner, 2001). Many optimization algorithms attempt to imaginatively capture some notion of SI. Indeed, many difficult optimization problems have been solved by so-called *ant algorithms* such as the Traveling Salesman Problem, the Quadratic Assignment Problem and other *NP*-hard optimization problems. These algorithms generally utilize some analogue of pheromone or some simple stigmergic-signaling mechanism. Ant-Net (Di Caro and Dorigo, 1997) for example, uses reinforcement learning to increase the probabilities of using certain routes in a routing algorithm. The probability value is used as an analogue to pheromone. Another example uses a similar update mechanism to control unmanned aerial vehicles (Helbing et al., 2001). These different approaches all try to take advantage of how social insects seem to function. These attempts to implement some SI characteristic however often are forced to creatively sidestep the concept of self-organization and its implications.

B. The Mystery of Self-Organization

Although much has been learned from observations of these social insects, there is no widely agreed upon definition of what constitutes SI. Indeed, the term *SI* is bandied about so often and in such a wide variety of contexts that it causes confusion leading to many different interpretations and implementations for various problems. Although many of these implementations reflect some notion of SI, they often entail other paradigms as indicated above such as *reinforcement learning* (Subramanian et al., 2005) and *stigmergy* (Peters et al., 2005) which refers to complex indirect interactions based on simple signaling systems (Angus and Hendtlass, 2002). Where do one paradigm end and the other begin? Still, other research seems to freely use the term SI when there simply are large numbers of interacting entities. Does that alone suffice to describe or define SI? Is it merely a way of somehow taking advantage of parallel computing methods?

Notwithstanding the many different descriptions offered by many researchers, the main features of SI seem to involve forms of limited or minimal communications and/or interactions, large numbers of interacting entities with limited reach, and some globally efficient, emergent or *self-organized* behavior. Bonabeau *et al*. (1999, p.9-11) suggests that the central features of SI are based on the manifestation of *self-organization* that arise from the interplay of four basic ingredients: 1) forms of positive feedback, 2) forms of negative feedback, 3) the *amplification of fluctuations* that give rise to structures, and finally 4) multiple interactions of multiple entities. But even this characterization provides very little insight into what SI is except in very descriptive terms. For example, it does not fully explain in a unifying way why or how pheromones evolved in the way they did, or why they should have the evaporative properties they have, or why they have their chemical makeup, or how ants can somehow distinguish among different types of pheromone (presumably in order to identify ants from other colonies, Wiener 1961, p.156).

Pheromones are complex chemical signaling systems, yet most of the research that deals with them or models their effects use the concept in very limited ways, *e.g.*, as a scalar in ant algorithms (Di Caro and Dorigo, 1998) as opposed to a more complex scheme represented by vectors. Although, as we shall see, even simple scalars can possess enough information related to a measure of efficiency, pheromones are likely to have more complicated properties than their mere intensity. Indeed, Wiener (1991) in his ground-breaking book *Cybernetics* emphasizes the importance of intercommunication among the entities in question: How then does the beehive act in unison, and at that in a very variable, adapted, organized unison? Obviously, the secret is in the intercommunication of its members. This intercommunication can vary greatly in complexity and content, the value of a simple stimulus, such as an odor, for conveying information depends not only on the information conveyed by the stimulus itself but the whole nervous constitution of the sender and the receiver of stimulus as well (Wiener, 1961, p.156-7).

However, one of IS central characterizations is that of *self-organization*. But this also begs the question of what constitutes SI because there is no clear understanding of what self-organization or emergent behavior is! These terms have been around for some time and their definitions have been and probably will continue to be debated for some time. Serra et al. (1990) describes the concept of self-organization generally as "highly organized behaviour even in the absence of a pre-ordained design" (Ferat and Kumar, 2002), but what is 'organized'? They go on to further describe examples such as the resonance phenomenon in lasers, and in cellular automata where "unexpected and complex behaviours can be considered as self-organized". Earlier, Prigogine and Stener (1984) described self-organization in chemical reactions and thermodynamic contexts. His notion is quite enlightening and emphasizes the element of *fluctuations* in far-from-equilibrium system states. Non-linear system changes, fluctuations as he refers to them, due to either random events or chaotic dynamics, are then amplified by positive feedback mechanisms.

This results in structures that emerge spontaneously which often are presented as examples of self-organization. It is interesting that Prigogine and Stenger (1984) provides an example of SI based on the clustering behavior of termites in constructing termite nests. Even earlier, Wiener (1961) used the term in describing the brain waves of humans. Again, the notion of what self-organization is remains unclear. Is it merely some structure or pattern? And if so, how is one to distinguish it from merely random effects? What is needed to truly take advantage of SI is more than the mere descriptions of the attributes of SI and self-organization. Something amenable to formal mathematical definition (Bianchi et al., 2002b) would be quite valuable. The concept of self-organization therefore plays a central role in the development of the foundational principles of SI.

These principles are founded on the notion that self-organized behavior of the type observed in entities subject to the laws of evolution involves forms of efficiency in resource allocation. It emphasizes the importance of *signals* as mechanisms of change in system states subject to the imperatives of the evolutionary pressures of natural selection. It is important to recognize that the response of insect swarms to external stimuli is governed by processing systems that have been heavily influenced and affected by the forces of evolution. This allows consideration of a much richer spectrum

of behaviors, both simple and complex, than those implied by the mere application of positive and negative feedback mechanisms to simple signals (Carling et al., 2003). In fact, the type of self-organization described here can be framed as a *form of symmetry* in that changes in the system's behavior and operating points nonetheless leave unchanged certain attributes associated with these operating points, namely, their Pareto optimality (Menczer et al., 2000). In short, a novel definition of self-organization presented here is *system behavior that maintains its operating points on or near a Pareto optimal frontier*. This notion of efficiency constitutes a central feature of the foundational principles for SI.

Insect societies have a working model that is very different from the human one: a decentralized model, based on the cooperation of autonomous units with a relatively simple and probabilistic behavior that are distributed in the environment and are provided only with local information (meaning they don't have any representation or explicit knowledge of the global structure they are supposed to produce or in which they evolve, that is they have no plan at all). Insects possess sensory equipment that allows them to respond to stimulations: those that are emitted by their peers and those emanating from their environment (Huberman and Helbing, 1999). Obviously these stimulations are not the same as words or signs with a symbolic value. Their meaning depends on their intensity and on the context in which they are produced; they are simply attractive or repulsive, inhibiting or activating. In insect societies, the global 'project' is not explicitly programmed within individuals, but emerges after the succession of a high number of elementary interactions between individuals, or between individuals and the environment. Their collective intelligence gets built from a multitude of individual simplicities.

Insect societies (ants, bees, termites, etc.) have become particularly observed models these past two decades. How can just the interaction of a high number of individually 'stupid' creatures cause the emergence of an intelligent, reactive, adaptable and in symbiosis with the environment? This is known as *swarm intelligence*. It has inspired many computer simulations (swarm computing and cellular automata), all providing fertile discoveries and teachings. Swarm intelligence is blind because of its lack of holopticism (Noubel, 2004). None of the individuals have the slightest idea of what the emerging entity is. What 'stabilizes' and manages social insects societies comes mainly from external conditions (temperature, weather, dangers, food, etc.) that work like a natural container' and provide behavioral guidelines and boundary conditions.

Millions of years of evolution were necessary to refine their genetic programming so that large numbers of individuals working in unison could create societies having the stability and robustness we know. It seems that, in humankind, a certain form of swarm intelligence shows up in the economic domain as well. Each time we make a payment, we make a gesture that is rather similar, in its simplicity and its dynamics, to an exchange between social insects. From the multitude of one-to one simple probabilistic transactions, an elaborated collective system emerges, with responsiveness and adaptive properties. This is the way human society manages and balances its resources at the macroscopic level (even though at the local level of organizations, it is pyramidal intelligence that organizes the circulation, as previously stated).

Challenges in the New Economy
The challenge is on the one hand to identify and understand swarm intelligence patterns and mechanisms and on the other hand adapt them to the right business problems. The key characteristics of swarm intelligent systems are:
- Decentralization
- Flexibility
- Robustness
- Self-Organization

Business problems and fields for which swarm intelligence based solutions can be adapted are:
- Design decision rules in complex and volatile environments (simple rules for individuals result in adaptive collective behavior)
- Optimization of process flows (define "virtual pheromone"-equation to ensure optimal routing)
- Planning of production site/ distribution network based on the rules of clustering and sorting
- Implementing flexible "bucket brigades" for optimal allocation of resources within a process In the future some of the following scenarios based on swarm intelligent mechanisms seem to be realistic:
- Self-healing, self-organizing communication networks
- Self-aggregating devices
- Swarm "urban combat model"

Limits of Swarm Intelligence

The success of swarm intelligence is subject to the condition that its agents are uniform and disindividualized. The latter, namely anonymous agents among the crowd of other anonymous agents, has a consequence. Individuals are easily sacrificed – even in large scale – in the name of the global balance of the system. Although this fact might seem acceptable for social insects in which each individual is undifferentiated, it is of course not acceptable for animal species whose health and balance depends on individual differentiation. Humankind is a particular poignant example.

Yet this fundamental distinction seems to be ignored by the numerous economic theories that build their models and doctrines on the interaction of undifferentiated agents such as the consumer, the citizen, etc. The liberal approach postulates that the system should reach its balance at the macroscopic level by itself, thanks to the action of internal and external constraints (some people will refer here to the famous Adam Smith's (Smith, 1910) expression of the *invisible hand*). Modeling human society as a sum of undifferentiated agents – even with random behavioral variations – constitutes an epistemological mistake at the best, a very dangerous doctrine at the worst. Let's add that the human economic system is a very recent evolutionary spark and that no historical or biological facts can back up the thesis of a so-called natural equilibrium. For this reason, it seems that the swarm organization is only a transitory stage. It leads to the construction of a new level of complexity that transcends and includes the previous levels. Swarm intelligence (Kennedy, 1999) that still characterizes our current economic system, will either collapse or evolve toward the next superior level, that of Collective Intelligence.

Collective Intelligence

The main stakes for humanity are not hunger, poverty, sustainability, peace, healthcare, education, economy, natural resources or a host of other issues but our capability to build new social organizations that are able to provide solutions. Our main stake is Collective Intelligence (Noubel, 2004). This is a key issue in the corporate world as well. Today most large companies encounter insurmountable difficulties when dealing with the complexity and the unexpectedness of the world when operating against a global backdrop. They undergo conflicts of interest in many areas – between profitability and sustainability, secrecy and transparency, values and value, individual and collective dynamics, and knowledge fertilizing – that opens – and competition – that closes.

What most medium and large organizations have in common is an infrastructure based on pyramidal hard-coded social maps, command and control, labor division, and a monetary system stimulated by scarcity. Until recently, this social architecture was the only information system at our disposal to pilot and organize complex human edifices. We call it *pyramidal intelligence*. It remains efficient as long as the environment remains stable, but it becomes vulnerable and inefficient in fluctuating contexts (Helbing and Platkowski, 2002), namely when markets, knowledge, culture,

technology, external interactions, economy or politics keep changing faster than the capability of the group to respond.

Evolution has provided humankind with specific social skills based on collaboration and mutual support. These skills reach their maximum effectiveness within small groups of 10 to 20 people, but no more, where the individual and collective benefit is higher than what would have been obtained if everyone remained alone. This is known as *original collective intelligence*. As individuals, we all know what it is because it is very likely that we have experienced it at some degree in our lives. Well-trained, small teams have interesting dynamic properties. These include transparency, a gift economy, a collective awareness, a polymorphic social structure, a high learning capacity, a convergence of interest between the individual and collective levels, interactions characterized by human warmth, and, above all, an excellent capability to handle complexity and the unexpected (Huberman and Helbing, 1999).

Is it possible for large organizations to benefit from the same properties? Can they become as reactive, flexible, transparent, responsive, and innovative as small teams? Can they evolve even further, toward a global Collective Intelligence? Can they conjugate their interests with overriding concerns of humanity such as ethics, sustainability, etc? The answer today is a resounding yes. It is not only possible, but absolutely necessary for not just the efficiency of these organizations but above all for the well-being of human society.

How Swarming Works?

History teaches us that the behavior of large masses of people can sometimes be very stupid. But crowds can also display surprisingly smart behavior. Recently, attempts have been made to mimic this *collective intelligence* of crowds in computers. Collective intelligence is the capability for a group of people to collaborate in order to decide upon its own future and reach it in a complex context (Noubel, 2004). Collective intelligence is neither a new concept nor a discovery. It is what shapes social organizations – groups, tribes, companies, teams, governments, nations, societies, guilds, etc. – where individuals gather together to share and collaborate, and find an individual and collective advantage that is higher than if each participant had remained alone. Collective intelligence is what we term a positive-sum economy.

Amazon.com uses a seemingly simple form of collective intelligence. When displaying a book, the site also shows books that people who bought the first book have bought. Clicking on one of these books leads to a page where yet more books that have been bought by persons buying the second book are shown. In this way, it is possible for a (Kirkpatrick, 1983) browser to utilize the collective intelligence of all other book-buyers and find new, interesting books. The search site Google can be seen as another form of collective intelligence. Here, the page ranking system increases a page's rating if many people link or surf to it. Another example is Alexa, which was a system for finding related sites.

Many artificial intelligence approaches and optimization methods rely on centralized and hierarchically organized systems (Yang and Kamel, 2003). These are most often built from a top-down perspective. Lately, an alternative approach has begun to emerge, inspired in part by swarming and the behavior of social insects. In contrast to naive belief, insects like ants or bees are not centrally controlled hierarchically by a queen ant or bee. Instead, these insects collaborate to solve complicated optimization problems implicitly (Gordon, 2002; Sumpter and Beekman, 2003). This collaboration is controlled by communication, sometimes directly (*e.g.*, bees dancing to show directions to food) or indirectly, by individuals changing their environment and thus providing guidelines for colleagues (this is called *stigmergy*).

Swarm intelligence is a relatively new methodology that takes its inspiration from the behavior of such social insects and flocking animals. Its uses include crowd modeling for movies (Koeppel, 2004), optimization (Bonabeau et al., 1999), military history (Edwards, 2000). Variants of it have also

been used in social sciences, *e.g.*, *sugarscape* (Epstein and Axtell, 1996). Originally, swarm intelligence was used in order to explain emergent biological phenomena suck as the flocking behavior of birds and fish or nest-building of termites. It has also been used for modeling robot behavior (Arkin, 1998). Swarming is a simple case of so-called *agent-based modeling*.

Principles and Applications of Swarming

The basic principle of swarming is very simple: by having a relatively large number of agents following very simple rules, complicated group-behaviors emerge. One of the key features of swarming is that it may not be possible to understand the emerging global behavior by analyzing these simple rules. The only way to predict the behavior of a complicated agent system may be to simulate it. After analyzing many such simulation (Suenson et al., 2004), it might be possible to extract "rules" governing the aggregate behavior of the system. In some cases, it might even be possible to relate these to the microscopic rules followed by the agents.

However, in other cases the microscopic rules may be completely counter-intuitive and seem to destroy rather than create the desired global behavior: doing wrong locally might be right globally. Such systems have a number of desirable features. They are robust, flexible and self-organizing. Robust since not all individual ants need to solve the problem. Flexible, since they can adapt in real-time to changing conditions. The self-organizing properties of swarming are important since they mean that there is no central command and control post that decides what the agents should do. This reduces the vulnerability of the system (Wolpert and Lawson, 2002).

Swarming can be seen as one kind of *self-organizing* system (Johnson, 2001). To give a taste of how swarming works, consider the following game. Take a large number of people and randomly assign a protector and an attacker to each person. Tell them that they must move around so that their protector is between them and their attacker. How will the crowd move? Since one person's attacker might be another one's protector, the motion of the crowd will be random. Consider the difficulty faced by an observer who enters the room while the crowd moves around and tries to discern the rules governing it. Contrast this to the situation that arises when the rule is changed in a very simple way: each person tries to move so that they are in between their attacker and protector. Now, everybody will try to move to the center of the crowd. Similar sets of rules can be used to explain how flocks of birds and schools of fish form3. This was the first and arguably still most successful application of swarming. Computer simulations show that such flocks and schools can be formed by having a large number of simple agents following very simple rules (*e.g.*, "don't collide", "try to move in the same directions as your neighbors", and "try to reach the center of your neighbors"). This technique has been used in many movies; one recent example is Return of the King (Koeppel, 2004). Here swarming is used to create realistic-looking scenes with hundreds of computer generated actors. The resulting aggregations are an emergent phenomenon, occurring when a large number of agents interact.

Similar rules have been found to explain how ants and other social insects find food, how termites build nests, and many other phenomena. The method used by ants to find food has inspired an optimization method (ant colony optimization) that has been successfully used to approximately solve a wide variety of hard optimization problems (Angeline, 1998b). The method uses a large number of simple agents that communicate by depositing pheromone in the search landscape of the optimization problem.

Each swarming agent reacts according to simple rules. One example of such rules are: "if there are few objects around me, pick one of them up" and "if there are many objects around me, drop the objects that I am carrying". Such rules lead to clustering, and variants of it can be used to explain how termites build their nests (Bonabeau et al., 1999). The same principle can also be used for sorting objects. Feedback is a very important principle in all swarming. Feedback can both reinforce and suppress behavior, depending on its desirability. When ants try to find food, the pheromone-path to a good food-site will be reinforced as long as it remains good. A small initial change in smell will thus be amplified and lead to large smell-differences in the terrain.

Main application areas are the optimization of complex technical networks, such as telecommunication or computer networks, and the understanding and optimization of business networks and process flows, as well as the development of sophisticated marketing approaches targeted towards the complex "hybrid customer". For the first application area examples already exist in the telecommunication industry: International carriers (e.g. BT, France Telecom, MCI) are using swarm intelligence based routing algorithms. The second application area attracts the interest of network-based industries such as logistics as well as companies relying on a smooth interaction with other companies within a business network. The marketing application offers interesting insights for consumer products, especially those involving high touch/ emotion.

Another application of swarming and agent-based simulation to logistics is implemented as a rule-based flow-handling system (Tarasewich and Mcmullen, 2002). Such a system has been implemented by Southwest Airlines several years ago. The airline reportedly saves $2 million per years on this. The BIOS consulting group, used agent-based modeling to simulate the behaviors of local freight-managers in the Southwest flight-network. The problem they were trying to solve was to minimize delays and maximize throughput of parcels. When an airport receives a lot of parcels, it may not have enough outgoing flights going to the correct destinations; this introduces unwanted delays in shipping. By experimenting, they found that introducing counter-intuitive rules for how local managers should allocate parcels to flights led to a very significant decrease in delays.

Unfortunately, the exact rules discovered have not been published (Silva et al., 2002). One example of such a rule could be "with probability 0.07, send the parcel on the first outgoing flight, even if it's in the wrong direction". Such rules seem to lead to undesired local behavior, but the aggregate behavior leads to a globally better optimum than trying to do best locally. Johnson (2001) gives a popular-level description of how swarming could be used to improve networks such as the World Wide Web. The Internet is the most successful example of a thoroughly decentralized structure that works. There are many ideas for how swarming could be used to improve routing in Internet, although the financial investments in legacy systems have so far been too large for any large scale experiments to be done.

Expanding to New Markets with Swarm Intelligence

Swarm intelligence may also hold important lessons for businesses seeking to find and exploit new markets. Consider how different species of ants attract their nest mates to new food sources. There are three basic ways in which ants lead their fellows to new food sources. Laying pheromone is a form of "mass recruitment": a large mass of ants is attracted down the path where the pheromone is strongest. In some species, though, an ant that finds a food source returns to the nest and vibrates its antennae to convince one other nest mate to return to the site. That's called "tandem recruitment." In other cases, an ant vibrates its antennae to get a number of nest mates to follow (Bonabeau and Meyer, 2001).

That is "group recruitment. In all three cases, individual ants can convey information about the quality of a food source, either by laying more pheromone or by increasing the frequency of their antenna vibrations. But it turns out that one method is much more effective under certain circumstances, as Jean-Louis Deneubourg (2005) and his colleagues at the Université Libre de Bruxelles discovered in a series of intriguing experiments. They placed a food source at a certain distance from a nest of ants and watched as the colony began to raid the food. Then they placed a source of richer food at a different location an equal distance from the nest. The colony using the mass recruitment approach was unable to shift to the better food because the trail to the first source was already reinforced too heavily. The colony using tandem recruitment diverted several individuals quickly, but the number was too small to take full advantage of the richer food source.

The colony practicing group recruitment was both flexible and efficient; many nest mates were quickly enlisted to raid the superior food source. Interestingly, mass recruitment is most often associated with large colonies, tandem recruitment with small colonies, and group recruitment with

medium-sized ones. This correlation is not accidental; millions of years of evolution have shaped it. For a large colony that can defend its food sources, a strong pheromone trail makes strategic sense, particularly when a huge food source, such as an animal corpse, is discovered. Small colonies are less able to defend themselves from predators and competitors, so a flexible foraging strategy is advantageous because it enables the ants to quickly move on to other food sources when they are threatened. Group recruitment appears ideal for medium-sized colonies in fast-changing, unpredictable environments: it allows the ants to exploit a food source efficiently while remaining flexible and capable of exploring their surroundings for additional sources.

These findings have implications for companies because the size of an organization, the characteristics of a marketplace, and the competitive environment are similarly intertwined in the business world. When markets are volatile and short-lived but sufficiently large, and when competition can emerge from anywhere, the ideal enterprise, would be of medium size (perhaps a business unit within a larger conglomerate). More important, the organization would do well to possess strong internal mechanisms that enable – if not encourage – group recruitment.

A Swarm of New Perspectives

The possible applications of swarm intelligence are unlimited. The way insects cluster their colony's dead and sort their larvae, for instance, has led to a novel approach for banks to use to analyze their data for interesting commonalities among customers. But it could be argued that in certain environments (a factory, for instance), humans are constrained in similar ways – although perhaps to a different degree – as insects are in a colony. And the parallels between social insects and people are more than just conceptual: they can have practical and useful significance, as recent research has shown. Indeed, swarm intelligence is becoming a valuable tool for optimizing (Huberman and Helbing, 1999) the operations of various businesses. Whether similar gains will be made in helping companies be better organized and develop more effective strategies remains to be seen.

At the very least, though, the field provides a fresh new framework for solving such problems, and it questions the wisdom of certain assumptions regarding the need for employee supervision through command-and-control management. In the future, some companies could build their entire businesses from the ground up using the principles of swarm intelligence, integrating the approach throughout their operations, organization, and strategy (Bonabeau and Meyer, 2001).

Conclusions

In the near future swarm intelligence will provide new approaches to solving mainly organizational challenges in business networks as well as for the optimization of flows in technical networks (e.g. IT/TC networks). Swarm Intelligence based approaches look at challenges in the modern world from a completely different perspective. This provides innovative solutions with significant impact in many application areas. The added value generated by these solutions is by far more significant than it would be with an incremental optimization based on existing paradigms. IT is necessary to deploy solutions based on these approaches due to the increasing complexity involved.

It will be interesting to pursue the translation of the knowledge already available in the academic environment into real business life. Finding the right match between the different swarm models and the relevant business challenges is one of the critical success factors. But also the development of new services and business models based on SI-approaches seems to provide an interesting research area. The described technological implications (e.g. self aggregating devices etc.) lie more than 5 years into the future.

References

[1]   Angeline P. J. (1998b), "Using selection to improve particle swarm optimization", IEEE Transactions on Evolutionary Computation, pp. 84–89

[2]   Angus D. and Hendtlass, T. (2002), "Ant colony optimisation applied to a dynamically changing problem", IEA/AIE Conference, pp. 618–627

[3]   Arkin R. C. (1998), "Behavior-based Robotics", MIT Press

[4]   Arquilla and Ronfeldt (2000), "Swarming and the future of conflict", Technical report, RAND http://www.rand.org/publications/DB/DB311/DB311.pdf

[5]   Bianchi L., Gambardella, L. M. and Dorigo, M. (2002b), "Solving the homogeneous probabilistic traveling salesman problem by the ACO metaheuristic", Ant Algorithms, pp. 176–187

[6]   Bonabeau E. and Meyer K. (2001), "A whole new way to think about business", Harvard Business Review

[7]   Bonabeau E., Dorigo M. and G. Theraulaz (1999), "Swarm Intelligence: From Natural to Artificial Systems", ser. Santa Fe Institute Studies in the Sciences of Complexity, New York, N.Y.: Oxford University Press

[8]   Bowyer R. S. and Bogner, R. E. (2001), "Self-organizing team formation for target observation, Signal processing, sensor fusion and target recognition X", Vol. 4380, SPIE, pp. 339–350

[9]   Bullnheimer B., Hartl F. and Strauss C. (1997), "An improved ant system algorithm for the vehicle routing problem," University of Vienna, Vienna, Austria, Tech. Rep., POM Working Paper No. 10/97

[10]   Carling C., Svenson, P., Martenson, C. and Carlsen, H. (2003), "A flock-based model for ad hoc communication networks", International Command and Control Research and Technology Symposium, Washington, DC

[11]   Deneubourg Jean-Louis (2005), Université Libre de Bruxelles

[12]   Di Caro G. and Dorigo M. (1997), "Ant-net: A mobile agents approach to adaptive routing," Université Libre de Bruxelles, Belgium, Tech. Rep., Tech. Report IRIDIA/97-12

[13]   Di Caro G. and Dorigo M. (1998), "Ant-net: Distributed stigmergetic control for communications networks," Journal of Artificial Intelligence Research, Vol. 9, pp. 317–365

[14]   Epstein J. M. and Axtell, R. (1996), "Growing Artificial Societies: Social Science from the Bottom Up", MIT Press

[15]   Ferat S. and Kumar, V. (2002), "A swarm intelligence based approach to the mine detection problem", International conference Systems, Man and Cybernetics, p. 23

[16]   Fleischer M. (2003), "Foundations of Swarm Intelligence: From Principles to Practice", Institute for Systems Research, University of Maryland, College Park, Maryland 20742

[17]   Gordon D. M. (2002), "The organization of work in social insect colonies", Complexity 7(6)

[18]   Helbing D. and Platkowski T. (2002), "Drift - or fluctuation - induced ordering and self-organisation in driven many-particle systems", Europhysics Letters 60, pp. 227-233

[19]   Helbing D., Molnár P., Farkas I., and Bolay K. (2001), "Self-organizing pedestrian movement", Environment and Planning B 28, pp. 361-383

[20]   Huberman B. A. and Helbing D. (1999), "Economics-based optimization of unstable flows", Europhysics Letters 47, pp. 196-202

[21]   Johnson, S. (2001), "Emergence", Penguin

[22]   Kaelbling L., Littmand M. and Moore A. (1996), "Reinforcement learning: A survey," Journal of Artificial Intelligence Research, Vol. 4, pp. 237–285

[23]   Kennedy J. (1999), "Small worlds and mega-minds: Effects of neighborhood topology on particle swarm performance", Congress on Evolutionary Computing, pp. 1931–1938

[24]   Kirkpatrick S., C. D. G. Jr., and Vecchi M. (1983), "Optimization by simulated annealing," Science, Vol. 220, pp. 671–680

[25]   Koeppel, D. (2004), "Massive attack", Popular Science (January)

[26]   Leon-Garcia A. and Widjaja I. (2000), "Communication Networks: Fundamental Concepts and Key Architectures", ser. Computer Science and Electrical and Computer Engineering. New York, NY: The McGraw-Hill Companies, Inc.

[27]   Littman M. and Boyan J. (1993), "A distributed reinforcement learning scheme for network routing", Carnegie Mellon University, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA 15213, Tech. Rep.

[28]   Maniezzo V., Colorni A., and Dorigo M. (1994), "The ant system applied to the quadratic assignment problem," Universite Libre de Bruxelles, Belgium, Tech. Rep., Tech. Rep. IRIDIA/94-28

[29]   Menczer F., Degeratu M., and Street W. (2000), "Efficient and scalable Pareto optimization by evolutionary local selection algorithms," Evolutionary Computation, Vol. 8, no. 2, pp. 223–247

[30]   Merkle D., and Middendorf M. (2002a), "Ant colony optimization with the relative pheromone evaluation method", EvoWorkshops, pp. 325–333

[31]   Noubel Jean-François (2004), Collective Intelligence-The Invisible Revolution, posted at: www.TheTransitioner.org

[32]   Peters K., Johansson A. and Helbing D. (2005), "Swarm intelligence beyond stigmergy: Traffic optimization in ants", Künstliche Intelligenz 4, pp. 11-16

[33]   Poundstone W. (1985), "The Recursive Universe: Cosmic Complexity and the Limits of Scientific Knowledge", Chicago, Ill.: Contemporary Books

[34]   Prigogine I. and Stengers I. (1984), Order Out of Chaos: Man's New Dialog with Nature, New York, NY: Bantam Books, Inc.

[35]   Schoonderwoerd R., Holland O., Bruten J. and Rothkrantz L. (1996), "Ant-based load balancing in telecommunications networks", Adapt. Behav., Vol. 5, pp. 169–207

[36]   Semet V., Lutton, E. and Collet, P. (2003), "Ant colony optimisation for e-learning: observing the emergence of pedagogic suggestions", Proceedings of the 2003 IEEE Swarm Intelligence Symposium, IEEE, p. 46

[37]   Serra R. and Zanarini G. (1990), "Complex Systems and Cognitive Processes", New York, NY: Springer-Verlag

[38]   Silva C. A., Runkler, T. A. and Sousa, J. (2002), "Ant colonies as logistic processes optimizers, Ant Algorithms: 3rd International Workshop", Vol. 2463 of Lecture Notes in Computer Science, Springer-Verlag, p. 76

[39]   Smith A. (1910), "An Inquiry into The Nature and Causes of The Wealth of Nations", ser. Everyman's Library, J.M. Dent & Sons Ltd, Vol I

[40]   Subramanian D., Druschel P., and Chen J. (2005), "Ant and reinforcement learning: A case study in routing in dynamic networks," Rice University, Department of Computer Science, Tech. Rep.

[41]   Sumpter D. J. T. and Beekman, M. (2003), "From nonlinearity to optimality: pheromone trail foraging by ants", Animal Behaviour 65

[42]   Sutton R. and Barto A. (1998), "Reinforcement Learning: An Introduction", Cambridge, MA: The MIT Press

[43]   Svenson Pontus, Christian Martenson, Hedvig Sidenbladh, Michael Malm (2004), "Swarm Intelligence for logistics: The Background", Swedish Defense Research Agency

[44]   Toffler A. (1991), "The Third Wave", New York, NY: Bantam Books

[45]   Tarasewich P. and McMullen, P. R. (2002), "Swarm intelligence: Power in numbers", C. ACM 45(8): 62

[46]   Wiener N. (1961), "Cybernetics: Or Control and Communication in the Animal and the Machine", 2nd ed. Cambridge, MA: The M.I.T. Press, Inc.

[47]   Wolpert D. H. and Lawson, J. W. (2002), "Designing agent collectives for systems with markovian dynamics", Autonomous Agents and Multi Agent Systems, AAI, p. 1066

[48]   Yang Y. and Kamel, M. (2003), "Clustering ensemble using swarm intelligence", Proceedings of the 2003 IEEE Swarm Intelligence Symposium, IEEE, p. 65.

Comparative Effectiveness of Neonicotinoid (Thiamethoxam) and Organophosphate (Azamethiphos) Against Synanthropic House Flies

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Abstract

Because of their filth breeding and filth feeding, the common houseflies (*Musca domestica*) are linked with mechanical transmission of a number disease, including cholera, dysentry, typhoid and trachoma in man as well as mastitis and eye infections in animals. The insects are closely associated with man and breeds well in animals and human wastes and other organic debris. Environmental sanitation is therefore fundamental measure in controlling the flies. Insecticides, in the form of residual treatments or baits can be used as supplement especially during disease outbreak.

An experiment was conducted to assess the relative effectiveness of two anti-fly bait formulations with active ingredients Neonicotinoid (1% Thiamethoxam) and organophosphate (1% Azamethiphos) against the common houseflies. The assessment was based on attractiveness and killing effects of the two baits to both laboratory raised and wild populations of houseflies. Flies attracted to the baits placed in a specified area in one hour, on tables in restaurants, were counted and the effect there after observed for 24 hrs. At the end of 9 days of data collection in different restaurants, both baits were found to be equally effective in terms of attraction as well as the killing, but the baits differed in "On-the-spot-kill".

Keywords: Thiamethoxam, Azamethiphos, bait, effectiveness, houseflies

Introduction

The common houseflies (*Musca domestica*) are ubiquitous insects with all insect stages of eggs, larvae, pupae and adults. They are highly active indoors and in warm environment, houseflies remain active and reproduce throughout the year. Houseflies frequently feed indiscriminately on any liquefiable solid food. They normally liquefy food by regurgitating digestive juices and their stomach content (vomit-

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drop) on the food substance. The liquefied food is then picked by mouthparts. They also frequent human and animal excreta, human food, feeding utensils and other rubbish (Lapage, 1968). In such process, the flies pick up pathogenic organisms, which may be transferred to another surface or survive gut passage and get deposited as fly-spot (Valent Biosciences, 2001). Moreover, the hairy legs of the flies could easily transmit pathogenic organisms mechanically. The flies are therefore linked to some human diseases due to this behavior.

Although houseflies are rarely the sole transmitting agents of disease epidemics, it has been confirmed that they play a significant role in the mechanical transmission of diarrhea diseases such as cholera, dysentry and eye infections such as trachoma. Therefore although these diseases can be transmitted by other routes, they are such important causes of child deaths and blindness that domestic flies should be considered of major significance as disease vectors (WHO, 2006)

Environmental sanitation is fundamental measure for fly control, especially eliminating fly breeding sites as disposal of refuse, manure and compost. It is well known that in areas where animals are present, dung of domestic animals is an important or major source of fly breeding (WHO, 1991). However, although pesticide treatment should be considered as supplement to basic sanitation, it must continue to be employed as the principal measure for obtaining rapid and maximum control of a vector or pest especially during epidemics (WHO, 1984).

Among the proposed method of pesticide control of flies is the use of toxic baits (WHO 1984, 1991), which can be applied as Paint-On baits, Dry scatter-baits or liquid sprinkle-baits. This paper reports on results of a series of experiments conducted to test the relative efficacy of two dry scatter-bait formulations against synanthropic flies.

Materials and Methods
Experimental sites

The fieldwork was done at Magugu Township, Manyara region, North Eastern Tanzania, using public tearooms and small restaurants. The laboratory work was done at TPRI Magugu field laboratory using laboratory-reared flies. The work was conducted between January – April, 2005. A bitter substance, AGITA® 1GB with a neonicotinoid (1% Thiamethoxam) as its active ingredients, in the form of dry scatter bait for adult fly control was tested and compared with SNIP® an organophosphate (1% Azamethiphos), in the form of dry scatter bait granules for adult fly control, to assess their relative effectiveness when used in the control of house flies. Sugar, to which flies are normally attracted, was used in this experiment as our untreated control bait.

Test procedures
Field Work

Three different tearooms/small restaurants were selected for the study. The room floors and tables were first thoroughly cleaned. The test was done using a quadrant made by joining four 30x 30cm plastic rulers using strong glue. This was then put on top of white blotting papers soaked in water. Three of such quadrants were made, one for AGITA, SNIP and the third for SUGAR (Control), each of which were then put in different restaurants.

The test products was then scattered on the area covered by the rulers, which was then made our "observation point". A sensitive weighing balance was used to weigh exactly 0.6g of AGITA®, SNIP® and Sugar and put each in different restaurants. Collection of data involved counting the number of flies landing inside the observation point for 1 hour. At the end of observation hour, all flies died inside the square were counted. Similarly all flies died outside the square observation point, on other tables and even on the floors within the same room were counted separately. Efforts were made to get all flies died or dropped inside the rooms, except those, which might have left the room through

the windows or door. The collected flies were all put in paper cups covered with a netting material and put in holding room for 24 hours, when the mortality was scored. Identification was made mainly by physical examination but where necessary identification key was employed (Clay et al, 1973).

The experiment was repeated by transferring the treatment to another restaurant among the three by systematic rotation in the form of 3x3 Latin-square design making 3 rounds, taking a total of 9 days.

Laboratory work

Three large cages (60x45x45cm) with metal frames and covered with mosquito net materials were made and used for the test. 0.6g of AGITA was scattered in 30x30 cm square on a blotting paper moistened with water. Twenty-five, three to four days old, laboratory reared flies were released in one of the cages. In the second cage, 0.6g SNIP was applied in the same way while SUGAR was applied in the third cages and used as our control. The flies were then left for 24 hours to give them enough time to feed, and mortality was scored.

Data Analysis

The total 1hour landing scores were 1og transformed [log (1+n)] to normalize distribution (Madsen & Marcie-Taylor, 1999) and comparisons made on the marginal means as a measure of attractiveness of products, as compared to moistened sugar to which flies are normally attracted. The percentage of flies collected from the 30x30 cm quadrant observation point after 1 hour were analyzed and compared by ANOVA using linear model as a measure of Knock Down (KD) effect of the products. The 24 hours mortality was analyzed and compared as a measure of killing effect of the products. Probabilities less than 0.05 were considered significant.

Results

Sorting of the flies in the field revealed that more than 95% of the collected flies were *M. domestica* and others being few Lucilia species and some few could not be identified. Data were analyzed only for *M. domestica*. Table 1 gives the total flies attracted to the three products. Although there was slightly less flies attracted to AGITA, the difference was not significant (P=0.086) from attraction to SNIP & SUGAR.

Table 1: Effect of AGITA, SNIP and SUGAR on attracted houseflies in 9 days.

	Total flies	% Dead Inside	% Dead outside	% Unrecovered
	Attracted	Quadrant	Quadrant	flies after exposure
AGITA	2245	20.7	31.3	48.0
SNIP	2981	72.8	12.0	15.2
SUGAR(control)	2728	0.0	0.15	99.85
P Value	0.086	0.00	0.00	0.00

During the one-hour observation in the tearooms, flies attracted to land on AGITA appeared to be irritated and flew away within a very short time. On the other hand, flies attracted to SNIP stayed much longer on the scattered product at the observation point. Consequently only a small percentage (20.7%) of flies were collected knocked down on AGITA after 1 hour as compared to 72.8% which were knocked down at SNIP[®] observation point. This difference was statistically different (P=0.00).

Conversely although it was not possible to recover all flies that were knocked down outside the observation point but a significantly higher percentage of flies were recovered knocked down outside AGITA observation point (31.3%) within the room than in SNIP (12%). This difference was also statistically different (P=0.00). All knocked down flies, which were kept for 24 hrs observations, eventually died.

Since the field trial in the tea rooms and restaurants could not give the actual percentage mortality of exposed/attracted flies as some flies could have escaped through the windows after getting exposed, a much controlled laboratory experiment was done using laboratory reared flies.

Results from the laboratory experiment, shows that although not significantly different (P>0.05) AGITA gave slightly higher 24 hrs fly mortality (98.7%) than SNIP (97.4%) in *M domestica*. There was no fly mortality in the sugar bait.

Discussions

The over all results showed that the two insecticide products (Thiamethoxam and Azamethiphos) were highly efficacious against domestic flies. The attractiveness of AGITA (Thiamethoxam) to wild flies was as good and comparable to SNIP (Azamethiphos) as well as moistened sugar to which flies are normally attracted. Although our field results had showed that a certain percentage of flies attracted or exposed to thiamethoxam managed to fly away after being irritated, our laboratory work confirmed that eventually they all dies. It appears from our observations and results that thiamethoxam inflict much irritation before the knock down effect and therefore allowing the flies to fly away to die somewhere else, far from the source site. Azamethiphos on the other hand, appear to cause an instant knock down effect giving the flies no time to fly away (on the spot kill), or else there is no irritant in SNIP. This effect of Azamethiphos cause most flies to die on dinning tables in the restaurants. Although mortality caused by both insecticides were almost the same, Thiamethoxam could be preferred over Azamethiphos by home and restaurant owners as only few flies will be seen dead on tables, something which could give negative feelings to family members or restaurant customers. A very small percentage of flies (0.15%) were found dead in our field control (Sugar). This is likely to have died from other factors.

Generally, both scatter bait formulations have shown high killing effect on the flies. However houseflies are one of insect species that has shown greatest ability to develop resistance to insecticides. Houseflies have shown resistance to a number of insecticides including organophosphates, organochlorides, carbamates and even pyrethroids (WHO, 1984,1991, 2006), Therefore environmental sanitation and hygiene is the best control option as a long-term strategy while chemical control with insecticides is indeed important in cases of disease outbreak or when rapid control of high fly population is required.

Acknowledgement

References

[1]   Clay T., Cogan B.H., Crosskey R.W, Freeman P., Ghauri M.S.K., Lewis D.J, Mattingly P.F, Oldroyd H, Pont AC, Potts W.H, Raggae D.R., Rice A.L, Sheals J.G, Smit F.G.A and Yarrow I.H.H (1973). Insect and other arthropods of Medical Importance. Ed., Kenneth. G.V. Smith. The trustees of the British Museum (Natural History) London, Pp 561

[2]   Lapage G (1968) Veterinary Parasitology, 2nd Edition. Oliver and Boyd, Edinburgh and London Pp 1182.

[3]   Madsen H & Marcie-Taylor (1999) Data Handling and Biostatistics. Use of SPSS 9.0 for Windows. Danish Bilharziasis Laboratory Public. Pp 204

[4]   Valent Biosciences (2001) "The Houseflies" at www.valentbiosciences.com/ (30 December 2004).

[5]   WHO (1984) Chemical Methods for the control of arthropod vectors and pests of public health importance. World Health Organization, Geneve, Pp 108.

[6]   WHO (1991) Vector control series. The housefly: Training and Information guide: World Health Organization WHO/VBC/90.987. Pp 62

[7]   WHO (2006): Pesticides and their application. For the control of vectors and pets of public health importance, Sixth Edition. WHO Doc. WHO/CDS/NTD/WHOPES/GCDPP/2006.1 Pp 114.

A New Validated High-Performance Liquid Chromatography Method for the Determination of Clavulanic Acid in Human Plasma

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Abstract

A simple and accurate high-performance liquid chromatographic method with ultraviolet detection at 311 nm has been validated for the determination of clavulanic acid in human plasma. Plasma samples were pretreated by direct deproteinization with acetonitrile. A good chromatographic separation between clavulanic acid and the internal standard was achieved using a reversed phase C18 μ-Bondapak column and a mobile phase, consisting of acetonitrile-phosphate buffer solution. The calibration curves were linear over the concentration range of 0.1-4 μg/mL clavulanic acid with determination coefficients = 0.9992. The method is accurate (bias < 7%) and reproducible (intra- and inter-day R.S.D. < 5%), with a quantization limit of 0.1 μg. Analytical recoveries from human plasma ranged from 96.72 to 98.66%. This fully validated method is rapid (total run time < 10 min) and requires a 500 μl sample. This assay is suitable for biomedical applications.

Key words: clavulanic acid, metronidazole validation, chromatography, human plasma, drug, internal standard

Introduction

Clavulanic acid is a novel β-lactam compound, which was isolated from the culture fluid of streptomyces clavuligerus (Reading and Cole, 1977). The compound is a potential inhibitor of a large number of β-lactamase enzymes that are responsible for the resistance of many bacteria to β-lactam antibiotics. In the presence of clavulanic acid, β-lactamase-labile penicillins are protected from degradation by cell-free β-lactamase preparations1 and by whole bacteria culture (Hunter et al, 1979, Vree et al, 2003, Martin et al, 1995).

The analysis of clavulanic acid and structurally related compounds is difficult chromatographically because the compound is polar and not well retained on conventional reverse phase HPLC columns. Some high performance liquid chromatography (HPLC) assays have also been developed. They usually involved pretreatment of clavulanic acid with imidazole (Bird et al, 1980), precolumn (Perez et al, 1991), and postcolumn derivatization or ion-pair HPLC (Foulstone and Reading, 1980, Martin and Mendez, 1988). More recently, very interesting HPLC procedures for simultaneous assay of amoxicillin and clavulanic acid have also been described, including HPLC with reversed phase (Haginaka et al, 1985, Pajchel and Tyski, 2003, Hoizey et al, 2002) or cyclodextrin

stationary phase with ultraviolet (UV) or amperometric detection (Chulavatnatol and Charles, 1993, Abounassif et al, 1991). Although those methods are accurate and sensitive, they have, only be validated for quantitative analysis in pharmaceutical preparations.

Although, clavulanic acid is also difficult to analyze mass spectrometrically (Eckers et al, 1996), high-performance liquid chromatography (HPLC)-mass spectrometric (MS) method has been developed for simultaneous determination of amoxicillin and clavulanic acid in human plasma using terbutaline as internal standard (Yoon et al, 2004). Clavulanic acid may be detected by using special microbiological assay method (Brown et al, 1976, Ball et all, 1980). It may also be determined biochemically by using its enzyme inhibitory properties against a suitable β-lactamase preparation (Reading and Hepburn, 1979).

In the present paper, the use of high performance liquid chromatography (HPLC) to rapidly determine low concentrations of clavulanic acid (Fig.1) in biological fluids is described. This method may be of use in the study of pharmacokinetics of formulations of penicillins such as Augmentin.

Figure 1: The structure of clavulanic acid (drug) and metronidazole (internal standard).

Clavulanic acid   **Metronidazole**

Materials and Methods

HPLC equipment: A spectra-physics pump SP8810 was used and injections were made with a Hamilton 25 μL syringe via rheodyne 7725 injector. The eluant was monitored using a spectra-physics variable wavelength UV detector type spectra-100 at 311 nm. The HPLC column (25 cm, inner diameter 4.6 mm) contained C18 μ-Bondapak support prepacked by Waters Associates. No guard column was used

Mobile phase: 960 mL of potassium dihydrogen phosphate (0.05) buffer solution (pH 5.1) was mixed with 40 mL of HPLC grade acetonitrile. The pH of the resulting solution was adjusted to be 3.1.

UV spectrophotometer: The UV prestudy measurements have been done using Jasco V-530.

Materials: Clavulanic acid as its potassium salt and Metronidazole were used as received from Hikma pharmaceutics-Amman-Jordan. Imidazole, free of UV-absorbing impurities and potassium dihydrogen phosphate 'analytical grade' were supplied by Merck. Methanol and Acetonitril (HPLC grade) were purchased from Scharlau Chemie S.A . Pooled plasma was purchased from the Jordanian blood bank. Water used in the standards and mobile phase preparations was doubly distillated in the Department of Chemistry -Petra University.

Preparation of Solutions

Stock solutions of clavulanic acid and metronidazole were prepared as 1 g/L in mobile phase (phosphate buffer/acetonitrile), pH 6.0). The solutions were stored at –20 °C and remained stable for at least 1 month. Standard solutions were freshly prepared for each run day.

Standards

Working solution of clavulanic acid (100 µg/mL) and metronidazole (50 µg/mL) were prepared by dilution of the stock solutions with phosphate buffer (pH 6.0). Standard solutions were prepared from this solution by serial dilution with phosphate buffer, to yield final concentrations of 0.1, 0.2, 0.5, 1.0, 2.0, 3.0 and 4.0 µg/mL.

Quality control standards: Clavulanic acid quality control standards were freshly prepared in pooled human plasma. 25, 75, 120, 175 µL of the working solution were spiked in 5 mL volumetric flasks filled with pooled plasma to get standard concentrations 0.5, 1.5, 2.5, 3.5 µg/mL. Plasma aliquots were stored at −70 °C until assay.

Derivatization procedure for clavulanic acid: The Imidazole reagent was prepared by dissolving 13.6 g of Imidazole in 50 mL water. 2 mL of 0.5 M HCl was added with stirring and the pH of the solution was adjusted to 6.8 using 5 M Na_2HPO_4. The Derivatization of clavulanic acid was done by the addition of 100 µL of Imidazole reagent to Plasma samples (500 µL each).

Extraction procedure for clavulanic acid from plasma samples after Derivatization: The samples were freshly prepared. They were stored at a temperature of -40 to -70 ˚C if the assays were to be performed at a later time. 500 µL plasma of each sample was transferred into a 1.5 mL micro-centrifuge tube. The samples were spiked with 100 µL of imidazole solution, which was prepared as described above. Using a vortex, the samples were mixed for 10 seconds and left to stand for 10 minutes to allow the derivatization reaction to complete. 100 µL of metronidazole working solution (50 µg/mL) were added and mixed by vortex for 10 seconds. 800 µL of acetonitrile (HPLC grade) was added to the mixture to precipitate proteins followed by mixing for 30 seconds using the vortex. The micro-centrifuge tubes were then moved to a centrifuge and the precipitate was separated at a speed of 5000 rpm for 7 minutes. 25 µL of the supernatant was introduced to the HPLC system.

System suitability: System suitability was determined by analyzing the results in such a way as to ensure that system suitability parameters fall within acceptable limits. Evaluation has included two parameters: separation and reproducibility. Trending of the separation and reproducibility criteria such as peak symmetry, selectivity, retention time and theoretical plates have been accomplished. The system proved to be suitable for the determination clavulanic acid in plasma samples.

Results and discussion

A method for the determination of clavulanic acid in human plasma was developed. This method involved pretreatment of clavulanic acid with imidazole (Fig.2) (Eckers et al, 1996). This method is validated and found to be highly sensitive, precise, accurate and selective. The method that involved the use of HPLC/UV shows a high resolution between clavulanic acid, metronidazole (Fig.4) and other endogenous interfering peak for plasma compounds.

Clavulanic acid is poorly retained on C18 reverse-phase columns. Retention times can be lengthened by using buffer eluents at acidic pH. Even under these conditions it was not possible to obtain clavulanic acid peaks distinct from interfering peaks for components in human serum or plasma samples. The dilution of plasma with phosphate buffer serves two purposes. First, the percentage binding was decreased by dilution, keeping in mind that the binding is weak. Second, the dilution with buffer maintains the pH around seven, at which the clavulanic acid is mostly stable.

The generation of a more suitable chromophore by derivatizing clavulanic acid before chromatography was considered as a mean of overcoming the interfering problems discussed earlier. The reaction of imidazole with clavulanic acid occurs readily at room temperature to form a relatively stable product absorbing at 311 nm (Eckers et al, 1996, Foulstone and Reading, 1982).

It is noteworthy that extraction of clavulanic acid from buffered plasma improved the analytical results and enhanced precision and accuracy while increasing the analytical signal. This can be explained by the fact that clavulanic acid is more stable in buffer solution with a pH range 6-8 (Eckers

et al, 1996, Aghazadeh and Kazemifard, 2001). In addition the experimental procedure adopted was able to reduce the degradation of clavulanic acid at basic or acidic pH values.

Figure 2: Derivatization of clavulanic acid by imidazole at room temperature.
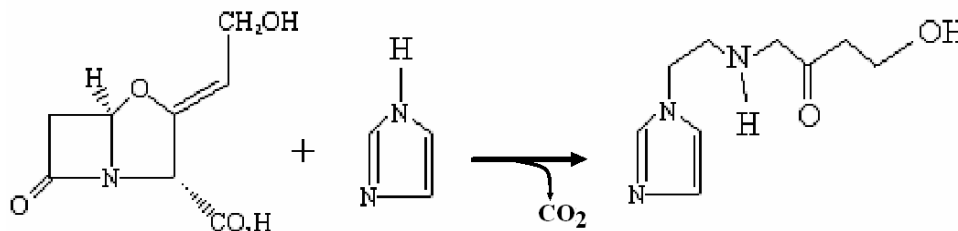
Quantization of clavulanic acid was performed using peak area ratios of the drug to the internal standard. A calibration curve with its corresponding quality control samples were run consecutively with every complete set of authentic samples pertaining to each part in the validation.

A series of standard plasma solutions previously spiked with clavulanic acid were employed as calibrators for constructing calibration growth curves covering the concentration ranging 0.1 and 4.0 µg/mL. The analyte and internal standard were extracted using the method described above. Linearity was demonstrated by calculating the product moment correlation coefficients R. **Table 1** summarize the generated data. Each calibration curve was constructed by plotting the area ratio (Area of clavulanic acid/Area metronidazole) versus the clavulanic acid concentration.

The linearity of the method was evaluated with calibration curves made in human plasma ranging from 0.1 to 4.0 µg/mL clavulanic acid. Each point was established from an average of seven determinations. A good linear relationship between detector signal and spiked concentrations was found, as described by the following linear regression equations: **Y = 0.0.5009X + 0.0191 (r^2=0.9992, r=0.9996),** where y is the area ratio and x is the concentration (µg/mL) (Fig.3). Values of the coefficients of determination are all satisfactory. Detection limit was determined as the concentration of components giving a signal to noise ratio 3:1. The limit of detection was found to be 0.05 µg/mL. The limit of quantization (LOQ) of clavulanic acid in plasma was chosen as the concentrations used for the lowest concentration level on the calibration curves and for which the R.S.D. was _14% (i.e. 0.10 µg/mL).

Figure 3: Calibration Curve growth for clavulanic acid using seven calibrators ranged 0.1-4.0µg/mL.
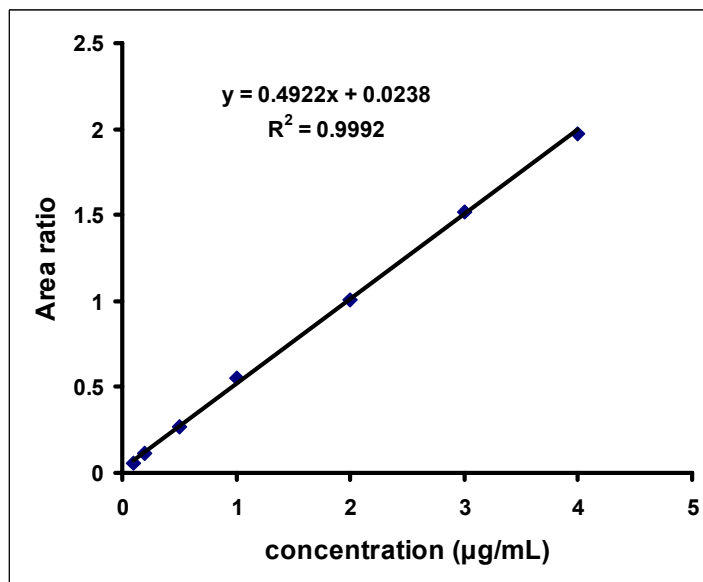
The limit of quantitation 0.1 µg/mL gave a coefficient of variation of 14.07% during the validation process.

The absolute recovery of clavulanic acid was determined by comparing the peak areas of the drug obtained from plasma extracts with the peak areas obtained by injection a pure aqueous standard at four different concentration levels namely 0.5, 1.5, 2.5 and 3.5 µg/mL. Absolute recoveries ranged 81.07% to 87.37%.

The relative recovery of clavulanic acid was calculated by comparing the concentrations measured from previously spiked plasma to analytical concentration added. Relative recoveries ranged from 96.72 % to 99.21 %.

Stability studies of plasma samples previously spiked with clavulanic acid were performed over 25 days. The results showed that the plasma samples could be safely stored at -70 ˚C without observing degradation of clavulanic acid.

The intraday precision was evaluated by analyzing plasma samples at four different concentration levels namely 0.5, 1.5, 2.5 and 3.5 µg/mL using six replicate determinations. The intraday precision ranged from 0.70% to 3.49 %.

Figure 4: HPLC chromatograms for clavulanic acid/metronidazole calibration standards. a) Blank b) 0.1(μg/mL), c) 0.2 (μg/mL), d) 0.5 (μg/mL), e) 1.0 (μg/mL), f) 2.0 (μg/mL), g) 3.0 (μg/mL), h) 4.0 (μg/mL). Retention times (clavulanic acid 5.7 min., metronidazole 8.5 min.)
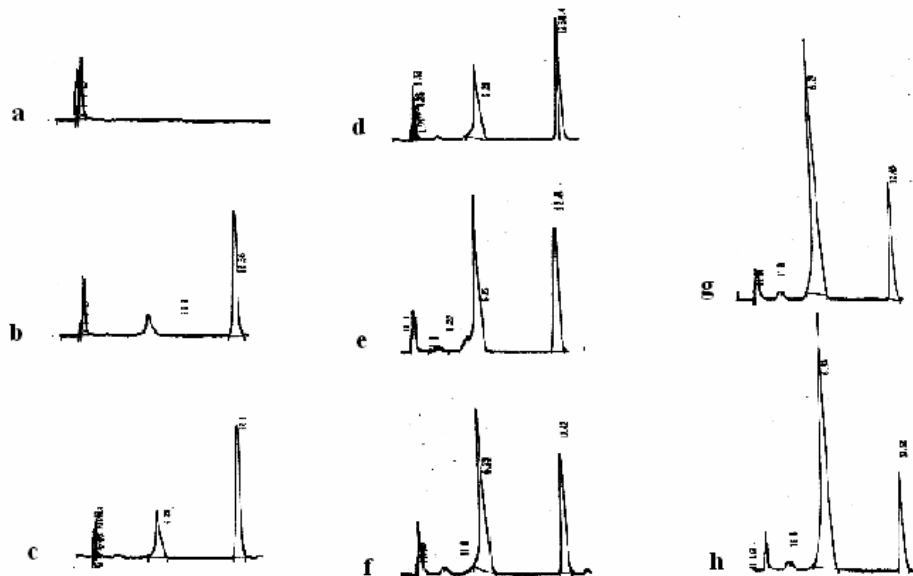
The effect of derivatization time on the clavulanic acid signal was evaluated by injecting the clavulanic acid for the same sample mixed with the derivatization agent after different periods of time. The clavulanic acid signal increased linearly as derivatization time increase (Fig. 5 and Fig.6). This can be explained by the fact that the derivatization clavulanic acid is more complete in buffer solution with a pH range 6-8 (Pajchel and Tyski, 2003, Brown et al, 1976). A good linear relationship between detector signal and time was found, as described by the following linear regression equations: **Y = 0.0.1016X + 0.0233 (r^2= 0.9984, r=0.9991),** where *y* is the clavulanic acid area and *x* is the time in minutes.

Figure 5: HPLC chromatograms show the effect of derivatization time of clavulanic acid with time. (Retention time clavulanic acid 5.7 min.).

clavulanic acid

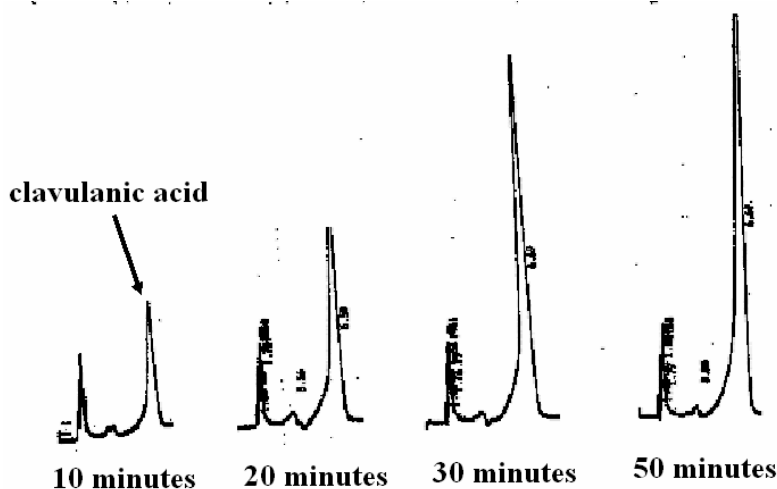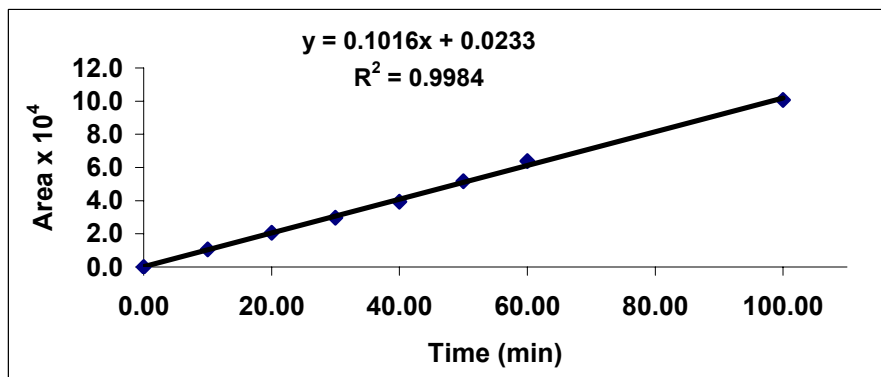10 minutes   20 minutes   30 minutes   50 minutes

Figure 6: The effect of derivatization time of clavulanic acid with time.

As a conclusion this method is well suited for the analysis of clavulanic acid in plasma samples that could be harvested from healthy volunteers after dosing with clavulanic acid tablets. The proposed method may represent an alternate rapid assay for analysis of clavulanic acid in pharmaceutical dosage forms. It is reasonable to assume that it will also be suited for bioequivalence studies.

Table 1: Analytical recovery, method precision and accuracy, long term stability, freeze and thaw test and linearity of clavulanic acid in human plasma ($n=7$).

Analytical relative recovery:		
Spiked plasma concentration (µg/mL)	**Mean recovered con. (µg/mL)**	**Recovery (%)**
0.5	0.483	96.72
1.5	1.488	99.21
2.5	2.458	98.35
3.5	3.453	98.66

Method accuracy:			
Spiked plasma concentration (µg/mL)	**Mean measured concentration**	**Accuracy**	
		Bias (%)	**Relative error**
0.5	0.4851	-0.905	-2.974
1.5	1.490	-0.797	-0.683
2.5	2.484	-1.443	-0.633
3.5	3.510	1.180	0.291

Method precision:		
Spiked plasma concentration (µg/mL)	**R.S.D. (%)**	**CV%**
0.5	0.14	2.12
1.5	1.38	2.40
2.5	2.73	2.22
3.5	4.79	2.09

Long term stability						
Spiked plasma concentration (µg/mL)	**Day 0**		**Day 12**		**Day 25**	
	Measured conc.	**recovery**	**Measured conc.**	**recovery**	**Measured conc.**	**recovery**
0.5	0.4866	97.33	0.4972	99.44	0.5068	101.36
1.5	1.5033	100.22	1.4623	97.49	1.5232	101.55
2.5	2.4607	98.43	2.4607	99.88	2.5100	100.40
3.5	3.4590	98.83	3.5413	101.18	3.6180	103.37

Freeze and Thaw cycles								
Spiked plasma concentration (µg/mL)	**0.5**		**1.5**		**2.5**		**3.5**	
	Measured conc.	**recovery**	**Measured conc.**	**recovery**	**Measured conc.**	**recovery**	**Measured conc.**	**recovery**
Zero time	0.4993	99.86	1.4941	99.61	2.5207	100.83	3.5063	100.18
Cycle 1	0.4938	98.77	1.4722	98.15	2.4285	97.14	3.4541	98.69
Cycle 2	0.4921	98.43	1.4622	97.48	2.5170	100.68	3.4751	99.29
Cycle 3	0.4848	96.95	1.4817	98.78	2.4562	98.25	3.5343	100.98
Cycle 4	0.4871	97.42	1.4650	97.67	2.4667	98.67	3.4867	99.62
Cycle 5	0.4777	95.54	1.4679	97.86	2.4332	97.33	3.4163	97.61

Linearity					
Spiked plasma concentration (µg/mL)	**Average area ratio**	**S.D.%**	**C.V%**	**At the 95% confidence level**	
				Confidence limit(±)	**Confidence interval**
0.1	0.053	0.75	14.07	0.0086	0.0172
0.2	0.11	1.83	13.78	0.0210	0.0420
0.5	0.27	2.63	13.47	0.0302	0.0604
1.0	0.55	3.92	8.53	0.0451	0.0902
2.0	1.01	9.28	12.15	0.1067	0.2134
3.0	1.52	7.48	6.88	0.0860	0.1720
4.0	1.97	3.59	2.56	0.413	0.0826

Acknowledgement

References

[1]   Abounassif M A, Abdel-Moety E M, Mohamed, M E, Gad-Kariem R A (1991) Liquid chromatographic determination of amoxicillin and clavulanic acid in pharmaceutical preparations. *J. Pharm. Biomed. Anal.* 9: 731–735.

[2]   Aghazadeh A, Kazemifard G (2001) Simultaneous determination of amoxicillin and clavulanic acid in pharmaceutical dosage forms by LC with amperometric detection. *J. Pharm. Biomed. Anal.* 25: 325–329.

[3]   Ball A P, Davey P G, Geddes A M, Farrel I D, Brookes G (1980) Clavulanic acid and amoxicillin: a clinical, bacteriological and pharmacological study. *Lancet*, i: 620- 623.

[4]   Bird A E, Bellis J M, Gasson B C (1982) Spectrophotometric assay of clavulanic acid by reaction with imidazole. *Analyst*, 107: 1241–1245.

[5]   Brown A G, Butterworth D, Cole M, Hanscomb G, Hood J D, Reading C, Rolinson G N, (1976) Naturally occurring β-lactamase inhibitors with antibacterial activity. *J. Antibiotics*, 29: 668-669.

[6]   Chulavatnatol S, Charles B G (1993) High-performance liquid chromatographic determination of amoxicillin in urine using solid-phase, ion-pair extraction and ultraviolet detection. *J. Chromatogr.* 615; 91–96.

[7]   Eckers C, Chalkley R, Haskins N, Edwards J, Griffin J, Elson S (1996) *Analytical Communications* 33: 215-218.

[8]   Foulstone M, Reading C (1982) Assay of amoxicillin and clavulanic acid, the components of Augmentin, in biological fluids with high-performance liquid chromatography. *Antimicrobial Agents Chemotherapy* 22: 753–762.

[9]   Hunter P A, Coleman K, Fisher J, Taylor D, Taylor E (1979) Clavulanic acid, a novel β-lactam with broad spectrum β-lactamase inhibitory properties. Synergistic activity with ampicillin and amoxicillin. *Drug Experimental Clinical Research* 5: 1-6.

[10]   Haginaka J, Wakai J, Yasuda H, Uno T, Nakagawa T (1985) High-performance liquid chromatographic assay of sulbactam using pre-column reaction with 1, 2, 4-triazole. *J. Chromatogr.* 341: 115–122.

[11]   Hoizey G, Lamiable D, Frances C, Trenque T, Kaltenbach M, Denis J, Millart H (2002) Simultaneous determination of amoxicillin and clavulanic acid in human plasma by HPLC with UV detection. *J. pharm. Biomed. Anal.* 30: 661-666.

[12]   Martin J, Mendez R (1988) *J. Liq. Chromatogr.* 11: 1697–1700.

[13]   Martin C, Mallet M, Sastre B, Viviand X, Martin A,. Micco P D, Gouin F (1995) Comparison of concentrations of two doses of clavulanic acid (200 and 400 milligrams) administered with amoxicillin (2,000 milligrams) in tissues of patients undergoing colorectal surgery. *Antimicrobial Agents and Chemotherapy* 39: 94-98.

[14]   Pajchel G, Tyski S (2003) Application of MEKC for determination of ticarcillin and clavulanic acid in Timentin intravenous preparation. *J. pharm. Biomed. Anal.* 32: 59-69.

[15]   Perez C G, Martin I G, De Aldana B R V (1991) *J. Pharm. Biomed. Anal.* 9: 383–386.

[16]   Reading C, Cole M (1977) Clavulanic acid: β-lactamase inhibiting beta-lactam from stereptomyces clavuligerus. *Antimicrobial and Agents Chemotherapy* 11: 852-857.

[17]   Reading C, Hepburn P (1979) the inhibition of staphylococcal β-lactamase by clavulanic acid. *Biochemistry Journal* 179: 67-76.

[18]   Vree T B, Dammers E, Exler P S (2003) identical pattern of highly variable absorption of clavulanic acid from four different oral formulations of co-amoxiclav in healthy subjects., J. Antimicrobial Chemotherapy 51: 373-378.

[19]   Yoon K H, Kim H J, Lee S Y, Kim W, Park J S (2004) Simultaneous determination of amoxicillin and clavulanic acid in human plasma by HPLC-ESI mass spectrometry. *J. Chromatogr. B, 813*: 121-127.

Percuniary Influences and Examination Ethics Violation in Nigerian Tertiary Educational Institutions

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Abstract

In recent times, the dream of the Nigerian nation to promote and sustain top level quality education that compares favourably with what obtains in great countries of the world, had suffered a major set-back, no courtesy of the upsurge and widespread of bizarre graft-driven examination ethics violation (EEV) malaise. The primary data volunteered by 37 lecturers drawn from some universities, polytechnics and colleges of education were quite auspicious. From all indications, EEV is highly vicious, infectious, and opprobrious. The study, therefore, did well to put up veritable grounds for well meaning stakeholders to parley, partner, and take a firmer stand towards EEV comprehensive wipe out. The imperativeness of dedication and precision in this regard cannot be over emphasized.

Introduction

In recent years, students in some tertiary educational institutions had devised a strange pecuniary scheme for inducing lecturers to award them underserved pass grades in courses taken at the end of each semester. In some cases, the amount paid determines the grade to be awarded. Albeit, concerned stakeholders contend that the society is to blame for all these, since it has given the impression that all that matter in employment/appointment circles is a good degree (paper qualification), and not necessarily sound knowledge, good manners or goodwill. The latter are rather seen as incidental. Worse still, many political office holders are so boastful, immodest, corrupt, and disgustingly pompous, when they as elites are expected to set standards and keep the pace. What can, therefore, be distilled from the above scenario is that the people's culture (general way of thinking and doing things) has become anti-personal development and anti-social progress (Fafunwa, 1972; Akpomi, 2004; Agundu, 2005).

In many instances, what some Nigerians (parents and wards alike) believe is inconsistent with what they practice. The inconsistency has gone to the extent that it now clearly affects academic values, amongst lecturers in particular. For example, Nigerians accept the imperativeness of education in personal, social and technological development, but in practice they seem to monetize, casualize and trivialize education by exaggerating affluence (materialism) as a symbol of prestige and recognition. It thus makes sense to think the quick/much money syndrome with contemporary antithetical societal

values and attitudes (Hess, 1988). This also explains why many are not concerned about the extent to which their conduct is right or wrong, moral or immoral. Little wonder, standards are rampantly and flagrantly warped, distorted, compromised and sacrificed for money. The three focal ingredients (attitude, morality and values) still define and determine the character of a person. If they are positive in the majority of people in a population, they visibly represent and optimize an ordered society (Maduewesi, 2002).

One of Nigeria's national educational goals is the inculcation of the right type of values and attitudes for the survival, sustainable growth and development of the individual and the Nigerian Society (FGN, 1998). The values that compromising (unethical) lecturers would inculcate in youths (undergraduates), who are the leaders of tomorrow, are better imagined. According to Achebe (1983), acts of indiscipline abound in many homes, offices, schools, and walks of life in the nation, but in minor proportions. The danger about minor cases of indiscipline is that, if left unchecked, is the possibility of outright lawlessness and criminality, even among the lecturers. The major concern/worry of well-meaning stakeholders, in this case, relate to the acts of indiscipline prevailing among leaders (who should and rightly should be counted on as role models). The indiscipline of an ordinary citizen, regrettable as it might be, may not pose much fatal threat to society, because it could be reasonably addressed, but on the contrary, the indiscipline of a leader easily degenerates into recklessness and atrocity. Lecturers need not be at the center of these issues because they are leaders as well as role models. It, therefore, follows that lecturers, invariably being closer to students in the educational system and learning process could be of immense help and significant positive/constructive influence as the youths forge ahead with the challenges/hurdles of total development.

Societies not only have a duty to inculcate the right attitudes in their people, but also an obligation to extend age-long values efficiently and effectively, to younger generations in order to promote unity, cultural traditions, and national purpose (Sadker and Sadker, 1997). In less developed countries (like Nigeria), value crisis is believed to result mainly as technological development mal-entity (side-effect), with so much socio-economic consequences. Formal education, scientific discoveries, economic expansion, urban development, social mobility and individualistic tendencies all together, bring in their trail, new interests, attitudes and values (Anameze, 1996). Indiscipline and corruption, therefore, touch on the attitudes, values and morality of the people. It is in this vein, unfortunately, that Nigeria is yet to significantly improve on its national records. For many years now, it has been placed amongst the top most corrupt nations of the World. Nzewi (1986) decried that Nigerian social values place too much premium on monetary (pecuniary) wealth, some of which are acquired through foul means, as gateway to honour and fame. Today, idealism, altruism and patriotism have been thrown to the winds, as even the youths are so negatively sensitized/galvanized that they now hold tenaciously to vices instead of virtues. Many campus especially tertiary institutions are now centers of gross indiscipline (fraud and all manner of EEV). On the part of adults, shameless and uncontrolled materialism, ethnicism, discrimination, unbridled corruption and naked pursuit of power have become the bane of the (nascent) democracy. All these go to show that the Nigerian national educational policy objective of character development is still far from being realized.

Values are quintessential elements that are meant to guide human life choices in a definite virtuous and auspicious direction (Anameze, 1996). The basic assumption remains that values are hinged on cognitive moral beliefs/concepts. This is in line with the inculcation premise underlying universal moral principles, although some would contend that values are relative to the peculiarities/obscurities of the focal environment/situation. The principles are to be applied according to cognitive development needs/potentials of the individual (Huitt, 2004). Furthermore, values could also be seen to have their roots neither in society nor individuals in the interaction between persons and society. Hence, the individuals cannot be explained outside of the environmental/situational context. Fisher (1982) thus promoted the view that individual thoughts, feelings and actions are intertwined with the beliefs, motives and behaviours of others in the society. In other words, it is necessary to

understand how the behaviour of an individual is influenced (and in it turn influences) the actions of their peers in the social setting.

This process of self-actualization, is so important to the proponents of the value clarification approach, that efficacy must be regressed on social factors and group pressures. The implication of this is that chosen values, to a large extent, vary with time, space and experience. They however remain relatively homogenous and consistent with other values in the system in so far as they are selected/accepted after a well-defined due process. These dynamics of value choice are equally egoistic and serve the purpose of ensuring the integration and harmonization of each new value. Values developed after being processed in this manner, aggregate to form an integral whole, with each asserting and defining and refining the individual that adopts them (Anameze, 1996). These theoretic complexes have recorded visible pragmatic reflexes even among lecturers (and students) in Nigerian tertiary institutions, who are central to this study. The following research questions were, thus considered very pertinent:

i. To what extent are students involved in examination ethics violation?
ii. To what extent are lecturers involved in examination ethics violation?
iii. To what extent has examination ethics violation negatively impacted on the values system lecturers?

The comprehensive hypothetical proposition (HP) for statistical testing was:

HPo: There is no significant difference in examination ethics violation patterns in tertiary educational institutions.

Methodology

The study population comprised 50 lecturers who were part of a get together organized by National Association Business Educators (NABE). The Business Educators were actually drawn from the nation's universities, polytechnics and colleges of education. A record breakdown showed that 17 lecturers were from universities, 28 from polytechnics, and 15 from colleges of education. Ultimately, an expeditious random sample of 37 lecturers was selected made up of lecturers 9 from universities, 16 from polytechnics and 12 from colleges of education respectively. Returns from other respondents could not be expected as the forum had to wind up as scheduled. The data collection instrument used was questionnaire structured on a three-point scale of Large Extent (LE), Small Extent (SE), and No Extent (NE), with all issues relating to impact of Examination Ethics Violation (EEV) on the value system of lecturers. Percentages were used predominantly to analyze the research questions while chi-square (X^2) non-parametric statistical technique facilitated the test of hypothetical propositions (HPs).

Data Analysis/Results

Highlights of data presentation and interpretation are contained in Tables 1, 2, and 3; while HP statistical test details are in Table 4, below:

Table 1: Extent of General Prevalence of EEV

Lecturers	Large Extent	Small Extent	No Extent	Total
University	8 (89%)	1 (11%)	(0%)	9 (100%)
Polytechnic	10 (63%)	5 (31%)	1 (6%)	16 (100%)
College of Educ.	8 (67%)	2 (16.5%)	2 (16.5)	12 (100%)
Total	**26 (70%)**	**8 (22%)**	**3 (8%)**	**37 (100%)**

Source: Research Data (2005)

Table 1 above shows 26 (70%) lecturers out of 37 indicated that (EEV) prevails in the three categories of higher institutions of learning to a large extent, and they were in the majority.

Table 2: Extent of Students' Involvement in EEV

Lecturers	Large extent	Small extent	No extent	Total
University	6 (67%)	3 (33%)	(0%)	9 (100%)
Polytechnic	4 (25%)	5 (31%)	7 (44%)	16 (100%)
College of Educ.	5 (42%)	3 (25%)	4 (33%)	12 (100%)
Total	**15 (40%)**	**11 (30%)**	**11 (30%)**	**37 (100%)**

Research Data (2005)

From Table 2 above, students are not exonerated and alienated from the widespread incidence of EEV, as 15 (40%) so affirmed, and they were in the majority.

Table 3: Extent of Lecturers' in EEV

Lecturers	Large Extent	Small Extent	No Extent	Total
University	6 (67%)	2 (22%)	1 (11%)	9 (100%)
Polytechnic	8 (50%)	4 (25%)	4 (25%)	16 (100%)
College of Educ.	6 (50%)	2 (17%)	4 (33%)	12 (100%)
Total	**20 (54%)**	**8 (22%)**	**9 (24%)**	**37 (100%)**

Research Data (2005)

Table 3 above established lecturers' involvement in EEV to a large extent, as 20 (54%} so affirmed. And they were in the majority. On how the incidence of EEV has impacted on the value system of lecturers, the data revealed that students no longer desire good skills, while professional standards have been lowered and morals dragged to the mud by lecturers. In fact, the latter are not longer proud of their calling to the end that the quality of education keeps dwindling. The male lecturers were found to be more involved in EEV than their female counter-parts. Nonetheless, many stakeholders are even more disappointed that the latter (women) are involved, as they are expected to make a difference, being less money-minded and more oriented to morals. The HP statistical results are detailed in Table 4 below:

Table 4: Chi-square (X^2) Computation for HP Test

Observed Frequencies (O)	Expected Frequencies (e)	$(0 - e)$	$(0 - e)^2$	$(0 - e)^2/e$ (x^2 cal)	X^2 Tab
8	6.3	1.7	2.89	0.46	
10	11.2	-1.2	1.44	0.13	
8	8.4	-0.4	0.16	0.02	
1	1.9	-0.9	0.81	0.43	
5	3.5	1.5	2.25	0.64	
2	2.6	-0.6	0.36	0.14	
0	0.7	-0.7	0.49	0.70	
1	1.3	-0.3	0.09	0.07	
2	1.0	1.0	1.00	1.00	
37	**37**	**NA**	**NA**	**3.59**	**13.28**

Source: Research Data (2005)

Table 4 above, the cardinal inferential statistics at 99% level of confidence and 4 degrees of freedom were:

$X^2_{Cal} = 3.59$; $X^2_{Tab} (0.01, 4) = 13.28$

$X^2_{Cal} < X^2_{Tab}$ (Null HP accepted)

This established that there is no significant difference in EEV patterns and prevalence in the tertiary educational institutions.

Discussion/Conclusion

A basic philosophical pronouncement in the National Policy on Education (NEP) emphasized the resolve to transform individuals into sound and productive citizens. With education, the enhancement of cognitive and affective faculties is accentuated even as the people get more refined. Their intellect, emotions, attitudes, dispositions and skills are also reshaped and rededicated for the best. The result, in the final analysis, would be high quality of character, inherent moral and social values and fulfilling culture among the generality of the people. Essentially this study has shown that those responsible for the training and refinement of citizens are so dear to stakeholders' hearts and should not be the ones, destroying the system by perpetrating EEV. For now, EEV is still very much prevalent in Nigerian Universities, Polytechnics and Colleges of Education. It is actually wrecking more havoc in Universities, closely followed by the Colleges of Education and then the Polytechnics. The trend implies that quality education fortunes are still dwindling several years even after the release of the third edition of the NEP.

Students and lecturers alike are guilty of EEV. It is so bad that, in recent times, many students (on the one hand) are not ready to study and yet desire to obtain excellent grades/certificates at all cost. On the other hand, lecturers want to live affluent lives like their counterparts in the oil/gas, banking, and allied sectors of the economy. They want to ride big cars, own/live in magnificent edifices, look attractive with their spouses, and enjoy all the good things of life. Succinctly, many lecturers wish to pride amongst the upper-upper class of society, the saying these days that teachers' ***reward is no longer in heaven but right here on earth***. This situation has made lecturers in some cases to place price tag on grades, particularly for indolent and desperate students. Consequently, some of the indulging lecturers hardly mark their examination scripts, a situation were ghost students (who for one reason or another have left the system but whose names are still on class lists) are inadvertently awarded pass marks. Project supervision is not also left out in this malaise, as some lecturers charge students (unapproved) sums of money so as to undertake the project writing or recycle old projects for the students. It is as serious as that!

Recommendations

In the light of the research findings, it is very necessary for decisive steps to be taken with every sense of expediency and urgency to wipe out EEV. More specifically:

  i. Student should, as a matter of policy, anonymously assess lecturers at the end of every semester, so that those found guilty of serious EEV could be sanctioned. If such drastic measures are not taken, institutional morals and professional standards, which are already in a big mess, cannot be redeemed.
 ii. Lecturers (with ideal class sizes) should mark and submit results of examinations (along with scripts, schemes and model answer) not later than one week after examinations are taken. Also, once these are submitted, no addition, correction or amendment should be entertained. The marking/submission period may be extended appropriately (or simply pro rata) for unusually large classes. This is expedient and pertinent because allowing too long a period between the time of examination and submission of results, and allowing people to change and correct grades of results already submitted, would accentuate and effectuate EEV.
iii. Examination audit committees (EACs) should be constituted along Faculty lines to vet examination scripts in all courses. The EAC should be provided with standardized marking schemes and model answers, to enable them vet the scripts and ensure that they have been well treated and scores stated truly and fairly. Members of such a committee should be persons drawn from other faculties, with tested and proven impeccable character.

All hands must be on deck to eradicate the endemic scourge of EEV in the tertiary educational system, so that in the near future, the institutions could rank among the best in the world.

References

[1]   Achebe, C. (1983). *The Trouble with Nigeria*. Enugu: Forth Dimension Publishers.

[2]   Agundu, P. U.C. (2005). *Repositioning Nigeria's Globalization Strategy*: The crux and Educational interface. Paper presented in NARD Annual National Conference at University of Port Harcourt, Choba, Rivers State, Nigeria.

[3]   Akpomi, M.E. (2004). Necessary Reforms for Improving Quality Assurance in Nigerian Universities. *Paper presented at the Annual Conference of Nigerian Association for Educational Administration and Planning (NAEAP)* at Jos, Plateau State, Nigeria. 27-30th September, 2004.

[4]   Akpomi, M. E. (2004). *Sorting among lecturers and its impact on our values*: The Business Educations' Perspective. Paper presented at the 19th Annual Congress of Nigerian Academy of Educators at LASU, Ojo, Lagos State, Nigeria. 22nd – 26th November.

[5]   Anameze, L. (1996). *Effective Guidance and Counseling for Nigerian Schools*. Enugu: CPA & Gold Production.

[6]   Fafunwa, A. B. (1972). "Education for nation building, national rehabilitation and reconstruction in post-war Nigeria". In A. Adaralegbe, (ed.). *A philosophy for Nigerian Education*, Lagos: Nigerian Educational Research Council: 257 – 264.

[7]   Fisher, R. (1982). *Social Psychology – An Applied Approach*. New York: St Martins Press.

[8]   Hess, B. B. (1988). *Sociology*. (3rd ed). New York: Macmillan Publishing Company.

[9]   Huitt, W. (2004). *Values. Educational Psychology Interactive*. Valosta, GA: Valdosta State University. http.// Chiron.Valdosta.edu/whuitt/col/affsys/values.html.

[10]   Maduewesi, J. E. (2002). *Education for Character and Skill Development*. In Ayotunde, A. & Olushola, (ed.). *Fafunwa Educational Foundation Symposium*, Lagos: Fafunwa Educational Foundation: 3 – 5.

[11]   Nzewi, E. (1986). *The Inter-relationship between Value Orientation and Value System and the Implications for Counseling*. The Counsellor. 6 (2): 61 – 76.

[12]   Sadker, M. P. & Sadker D. M. (1997). *Teacher, School and Society*. (5th edition). New York: McGraw Hill.

Epidemiology of Upper GI Bleeding in a Nigeria Teaching Hospital

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Abstract

Upper GI endoscopy is a very useful tool in the diagnosis and treatment of upper GI bleeding. It is highly accurate in establishing an accurate diagnosis. The sensitivity and specificity of endoscopy have been reported as 92% to 98% and 33% to 100%, respectively.

In Nigeria and many developing countries, upper GI endoscopy services are not readily available nor affordable for most patients. Our centre introduced the Endoscopy Services about two years ago and we present our findings on those patients who were referred to us as a result of upper GI Bleeding.

This is a retrospective study of all patients referred to our endoscopy unit as a result of upper GI Bleeding. The study period was two years (2002-2003). The studies were carried out at Aminu Kano Teaching Hospital , Kano and Maranatha Specialist Hospital, Aba, Nigeria.

Data were collected from medical records of all patients on a standard form which included age, sex, clinical presentation, endoscopic findings and etiology.

A total of 73l patients had upper GI endoscopy during the study period of two years (2002-2003). Out of this number, 32(4.37%) were referred as a result of recent upper GI Bleeding.

Most of the patients were Males (24) accounting for 75% of all the Patients.

The age ranged from 18-75 years. Majority of the patients (81%) were below the age of 60years.

The commonest aetiology was Peptic Ulcer(37.5%) of which Duodenal Ulcer was commoner(75%). Bleeding from esophageal varices and Gastritis accounted for 18.75% each. Gastric Malignancies were the cause in 15.6% of the series.

In 9.37% , no obvious pathology was seen on endoscopy.

Considering the fact that the major causes of upper GI bleeding in our study are preventable or at least treatable (helicobacter, Hepatitis B, aflatoxins, NSAIDs abuse), efforts should be geared towards the eradication of these preventable problems.Health education, improved hygiene and increased funding of our Health Institutions will go a

long way in significantly reducing the incidence, morbidity and mortality of upper GI bleeding.

Introduction

Upper gastrointestinal bleeding is an alarming symptom to a patient, no matter how small it is. It remains a common cause of emergency hospital admissions and could result in significant morbidity and mortality. It constitutes a significant clinical and economic burden. It has a prevalence of between 50 and 150 hospital admissions per 100,000 adults per year (1), at an estimated total cost of $750 million in U.S. dollars (Van Leerdam et al, 2003; Longstreth et al, 1995; Gilbert et al, 1990; Rockall et al, 1995; Jinarek, 1996)

In the last 30 years endoscopy has become the method of choice in the diagnostic approach of upper GI bleeding(Lieberman et al, 1993). The sensitivity and specificity of endoscopy have been reported as 92% to 98% and 33% to 100%, respectively (Barbano et al, 1990; Silverstein et al, 1981; Salvador et al, 1990; Zaltman et all,2002)

In Nigeria and many developing countries, upper GI endoscopy services are not readily available nor affordable for most patients. This has limited the gathering of precise epidemiological data on the aetiology of upper GI bleeding as most patients are treated without any endoscopic evaluation to assess the aetiology and response to treatment(Atoba, 1984; Agaba et al, 2004)

Our centre introduced the Endoscopy Services about two years ago and we present the preliminary findings on those patients who were referred to us as a result of upper GI Bleeding.

Materials and Methods

This is a retrospective study of all patients referred to our endoscopy unit as a result of upper GI Bleeding. The study period was two years (2002-2003). The studies were carried out at Aminu Kano Teaching Hospital , Kano and Maranatha Specialist Hospital, Aba, Nigeria.

Data were collected from medical records of all patients on a standard form which included age, sex, clinical presentation, endoscopic findings and etiology.

Results

A total of 73l patients had upper GI endoscopy during the study period of two years (2002-2003). Out of this number, 32(4.37%) were referred as a result of recent upper GI Bleeding.

Most of the patients were Males (24) accounting for 75% of all the Patients.

The age ranged from 18-75 years. Majority of the patients(81%) were below the age of 60years.

The commonest aetiology was Peptic Ulcer(37.5%) of which Duodenal Ulcer was commoner(75%). Bleeding from esophageal varices and Gastritis accounted for 18.75% each. Gastric Malignancies were the cause in 15.6% of the series.

In 9.37% , no obvious pathology were seen on endoscopy

Table1: Sex Prevalence

Sex	Prevalence in %
Male	75% (24)
Female	25%(8)
Total	100%(32)

Table2: Aetiology Incidence

Aetiology	Incidence in %
Pud	37.5
Gastritis	18.75
Varices	18.75
Gastric malignancy	15.6
Normal findings	9.37
TOTAL	100%

Discussion

Upper GI bleeding is a common and potentially fatal clinical condition.

The advent of endoscopy especially the flexible fibreoptic type has impacted positively on the accuracy of diagnosis and has improved the management of the condition.

However, Nigeria and other poor resource countries have few centres offering these facilities which are often unaffordable to most patients. In most centres in Nigeria, the cost of a session of diagnostic upper GI endoscopy ranges from thirty five to seventy US Dollars($35-$70). On the other hand, the minimum income of an average Government staff is less than fifty dollars a month.This accounts for the small number of patients we see in our centres.

The commonest aetiology in our study was Peptic Ulcer Disease, followed by Gastritis.

This finding is not surprising because of two factors which are prevalent in our environment. These are the high prevalence of Helicobacter pylori infection and the abuse of drugs especially non steroidal anti-inflammatory drugs (Van der Hulst, 1997)

Since the discovery of Helicobacter pylori in 1983, its role in the causation and persistence of gastro-duodenal disease (Peptic ulcers, gastritis, erosions, duodenitis, gastric malignancies) has been well established (Graham et al, 1993; Labenz et al, 1994; Oluwasola et al, 2002)

Helicobacter prevalence in Nigeria population is not only high in the dyspeptic patient group but also very high in the normal population. Incidence of between 70-80% has been recorded in most studies carried out (Ndububa et al, 2001; Holcombe et al, 1990; Kent-Man Chu et al, 2005).

This is rather unfortunate as in most developed countries, concerted efforts to treat helicobacter pylori infection has resulted in a significant reduction in the incidence of Peptic Ulcer Disease (Baba et al, 2000).

NSAIDs abuse especially indiscriminate use and purchase of these drugs across the counter has also increased the incidence of Peptic ulcer disease and gastritis.

Regulations to discourage the dispensing and prescription of drugs by unqualified personnel will go a long way in reducing this negative trend.

The high prevalence of esophageal varices in our centre is underscored by the high prevalence of chronic Liver Disease in our population.

High prevalence of Hepatitis B infection and consumption of food contaminated by aflatoxins are widely responsible(Bojuwoye et al, 1996; Olubuyide et al, 2004; Malu et al, 1995)

The incorporation of HBV vaccination in the national programme on immunization currently in use in Nigeria is highly recommended. This would be an effective method of preventing HBV infection from childhood

Our study also confirms others done previously that the incidence of duodenal ulcers in the Nigerian population is much higher than that of gastric ulcers(Malu et al, 1995).

The age of the study population is relatively younger than in the Caucasians as the majority of our patients are below 60years unlike other studies done in Europe and North America[2]

Considering the fact that the major causes of upper GI bleeding in our study are preventable or at least treatable (helicobacter, Hepatitis B, aflatoxins, NSAIDs abuse), efforts should be geared towards the eradication of these preventable problems.

The incorporation of HBV vaccination in the national programme on immunization currently in use in Nigeria is highly recommended. This would be an effective method of preventing HBV infection from childhood

Health education, improved hygiene and increased funding of our Health Institutions will go a long way in significantly reducing the incidence, morbidity and mortality of upper GI bleeding.

References

[1]   M. E. van Leerdam, et al (2003) : Acute Upper GI Bleeding: Did Anything Change? Time Trend Analysis of Incidence and Outcome of Acute Upper GI Bleeding Between 1993/1994 and 2000. Am J Gastroenterol . 98:1494-1499.

[2]   Longstreth GF(1995). Epidemiology of hospitalization for acute upper gastrointestinal hemorrhage: a population based study. Am J Gastroenterol 90:206-210

[3]   Gilbert DA (1990).Epidemiology of upper gastrointestinal bleeding. Gastrointest Endosc 36 (suppl):S8-S13

[4]   Rockall TA, Logan RFA, Devlin HB, Northfield TC(1995). Incidence of and mortality from acute upper gastrointestinal bleeding in the UK. Br Med J 311:222-226.

[5]   Jiranek GC, Kozarek RA(1996). A cost-effective approach to the patient with peptic ulcer bleeding. Surg Clin North Am.76:83-103

[6]   Lieberman D (1993).Gastrointestinal bleeding: initial management. Gastroenterol Clin North Am 4:723-36.

[7]   Barbano P.R., Coviello D., Mariani M., et al (1990). Hemorrhages of the upper gastrointestinal tract. A comparison of the diagnostic accuracy between endoscopic and radiological examinations, MinervChir 45: 1003--1008

[8]   Silverstein F.E., Gilbert D.A., Tedesco F.J., et al(1981). The national ASGE survey on upper gastrointestinal bleeding: Study design and baseline data. *Gastrointest Endosc* 21: 73--79

[9]   Salvador Anez M., Gonzalez Guerra H., Pacheco J.L., et al(1990). Value of emergency endoscopy in upper digestive hemorrhage, *G E N*. 44: 125--133.

[10]   Cyrla Zaltman et all(2002). Upper Gastrointestinal Bleeding in a Brazilian Hospital: a retrospective study of Upper Gastrointestinal endoscopic records. Arq Gastroenterol. 39:74-80.

[11]   Atoba MA(1984). Endoscopy service in a developing country: problems and suggested solutions. Trop Doct. 14:79-81.

[12]   Agaba EI, Agaba PA, Wigwe CM(2004).Use and abuse of analgesics in Nigeria: a community survey. Niger J Med. 13:379-82.

[13]   Van der Hulst R W, Rauws E A, Koycu B, et al(1997). Prevention of ulcer recurrence after eradication of Helicobacter pylori: A prospective long-term follow-up study. Gastroenterology. 113 : 1082-6.

[14]   Graham DY, Hepps KS, Ramirez FC et al(1993). Treatment of Helicobacter pylori infection reduces the rate of rebleeding in peptic ulcer. Scand J Gastroenterol 28: 939-42.

[15]   Labenz J, Borsch G (1994). Highly significant change of the clinical course of relapsing and complicated peptic ulcer disease after cure of Helicobacter pylori infection. Am J Gastroenterol. 89: 1785-8

[16]   Oluwasola AO, Ola SO, Saliu L, Solanke TF(2002). Helicobacter pylori infection in South Nigerians: a serological study of dyspeptic patients and healthy individuals. West Afr J Med. 21:138-41.

[17]   Ndububa DA, Agbakwuru AE, Adebayo RA, Olasode BJ, Olaomi OO, Adeosun OA, Arigbabu AO (2001). Upper gastrointestinal findings and incidence of Helicobacter pylori infection among Nigerian patients with dyspepsia. West Afr J Med. 20:140-5.

[18]   Holcombe C, Lucas SB, Umar H, Abba A (1990). Helicobacter (Campylobacter) pylori in Africa. *Trans* R Soc Trop Med Hyg. 84:294-6.

[19]   Kent-Man Chu, Ka-Fai Kwok, Simon Law, Kam-Ho Wong (2005). Patients with *Helicobacter pylori* positive and negative duodenal ulcers have distinct clinical characteristics. World J Gastroenterol 11:3518-3522

[20]   Baba MM, Ajayi BB, Ekanem IA(2000). Prevalence of hepatitis B surface antigen among patients suspected of liver diseases in a Nigerian hospital. *Niger Postgrad Med J*. 7:91-5

[21]   Bojuwoye BJ(1996). The burden of viral hepatitis in Africa. East Afr Med J. , 73:233-5.

[22]   Olubuyide IO (2004). Natural history of liver Cirrhosis in 116 Nigerians. *Niger Postgrad Med J*. 11:91-6.

[23]   Malu AO, Sobala GM (1995). Prevalence of gastric and duodenal ulcers at endoscopy in Nigerian and British patients. Afr J Med Med Sci. 24:239-41.

Soft Modeling of Group Dynamics and Behavioral Attributes Conceptualizing Stigmergic Coordination

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Abstract

Social networking, religion and culture of human beings play a major role in the day-to-day activities performed by each individual in group oriented missions. The aggregation and inertia in the group are typically important to achieve the goal. A leader being the most dominant and knowledgeable steers the movements, thought processes, and actions of the individuals of his/her group. However the psychology of each individual is unique. This complex behavior is often observed in the software development projects, where the cognitive attributes and contribution of programmer's mind are some of the basic attributes to develop a project. This paper proposes a simulation model based on the behavior of the software developer in software development project incorporating fuzzy logic as a tool and subsequently demonstrates necessary concepts for software architecture to allow stigmergic activity of agents. The implication of this model also assists in gaining substantial information about the learning environment of the programmer, their control behavior during the actual implementation and post session of the project.

Keywords: Group inertia, Stigmergy, Psychology, software developers, Cognitive attributes, Soft Computing, Simulation

Introduction

Group dynamics play a major role during any development process involving psychological and cognitive computing etc (Kurosu et al, 1992). Human beings, being social animals, like to interact, neglect and communicate (i.e. act in various ways). They do not have the tendency to be idle for long. They must do something or the other, either physically or mentally. The way a group/team acts reflects the way it will perform in the near future. Any software development project could also be considered as a group activity. As a whole, their inertial movements (both physical and behavioral) implicate and affect the software development project. The movement of group members also put a substantial impact on the resultant (Gray et al, 2000). Mathematical models have been solicited to account age

difference in hierarchical navigation system, which is monitored mainly on age related differences (Zaphiris et al, 2003).

Behavioral representation in synthetic forces is the modeling of human behavior as it relates a particular mission. These models should incorporate the spectrum of human biomechanical, physical and psychological parameters, responses and interactions. All such attributes make human behavior highly complex non-linear and adaptable systems. Recently soft computing approaches have been used to address these complex issues (Gary et al, 1999). Among the various soft computing paradigms, the hybrid model (combination of neural learning and fuzzy logic) has been already applied in manifold applications successfully. Using a fuzzy inference method, *if-then* rules can be formulated which use linguistic expressions to model the human behavioral problem whereas the neuro-fuzzy approach offers a powerful method to model human behavior. The aim of this paper is to analyze the group dynamics as well as the programmer's mental state behind a software development project, which in turn enables to construct the inference tree indicating the outcome of the project success. The project has also highlighted the scope of simulation assuming the dynamic equation of individual members.

Software Development Process
The software development process mainly comprises of the following phases:
- Problem recognition, Analysis, Feasibility study, Design, Coding, Testing, Implementation, and Maintenance/post implementation.

Different software engineering process models have also been proposed to enhance the development process:
- Linear sequential model, Prototyping model, RAD model, Spiral/win-win spiral model, Incremental model, and Concurrent development model

All these models claim different methodologies of the development process, though the base remains the same. The models apply different views to facilitate the same Software Development Life Cycle (SDLC) approach. Each of these models requires their individual rations; time constraints, number of developers, cost estimates etc. The process model describes the methodology of implementation but is unable to precise the compatible process to shape the project into success. There are a lot of factors, which monitor any software development project, e.g.: deadline constraints, exact output format expected from the development team etc.

As the software project is a team effort or a cumulative group activity a group behavior in the development phase is functionally one of the most important criterions in the light of behavior modeling of the team members. Substantial works have been solicited relating group behavior of the crowd (Helbing, 1991; Musse and Thalman, 1997). Crowd is a composition of different people with different mental behavior with/without a goal, whereas a software development team is an intelligent crowd dedicated towards a particular goal.

Therefore broadly this project visualizes a solution space considering typically a software development scenario, where effort is different from project to project. In turn this exhibits different mental state of software developers, synchronized with their physical movements in the solution space. Any project of software development has the skill scale marked as follows: Rigorous coding, creativity, analytical ability, patience, endurance level, adaptation to correction (due to Megalomania, Extraordinary sense of superiority complex), etc.

Related Research
Psychology and behavioral analysis model through simulations have been considered in many significant works (Morisio, 2000; Musse and Thalman, 1997). The Personal Software Process (PSP) is based on the hypothesis that the performance of individual programmers can be improved by applying

sound techniques (such as receivers and effort estimation methods) within a defined process (plan, design, code, review, compile, test, post implementation). This entire spectrum depends on the behavior and mental state of the developer. Complete software development life cycle also has gained potential to some extent. Ali and Alain (Ali and Alain, 2001) used fuzzy logic to measure the software project similarity. To model complex human behavior several attempts have been configured with the help of neuro-fuzzy systems (Gary et al, 1999). In software development project, human involvement or involvement of programmers is the basic foundation block. The human i.e. programmer is goal specific, intelligent, may be a good or bad learner, may reciprocate to the situation with different sense of inertia individually. Thus analyzing the behavior of software programmer and its mathematical psychology may lead to a pioneering model, which directly or indirectly explains cognitive soft computing, behavioral study performance measure, etc for a given project. The style of construction of programs is crucially important and it depends on the programmer's ability and thought process.

In cognitive psychology (Eysenck and Keane, 1990) thinking process models are often used to explain how we reason about the world around us. Such a model can be seen as a simulation of an object or an abstract concept. Similarly programmers, while creating a system, create a number of mental models of a given system and try to interpret it in the computer language through a program. The speed at which a cognitive model of given system (Moström and Carr, 1998) could be created may vary from programmer to programmer, considering his/her experience and learning factor from the present paradigm (Hanakawa et al, 2002) or from past projects. Therefore, all the dynamic attributes of the software developer, adept to change, also significantly tell about the success of the project (Hanakawa et al, 2000; Hanakawa et al, 1998). The effort here is made to incorporate soft computing, typically fuzzy logic based algorithmic and mathematical model to simulate such behavior and thus to reach to the successful or failed status of the project, depending on the mental and behavioral state of the programmer. The ideal office is modeled in Figure 1, which also describes the movement of each individual depending on the role or assignment he or she has been given and at the same time leading to different mental states.

Figure 1: Ideal office scenario.
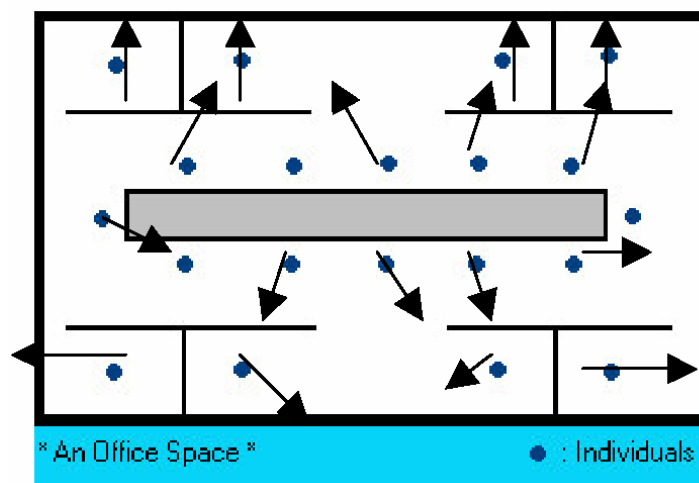
Modeling Group Dynamics
This section describes a model of group dynamics eventually involved in a standard software development scenario.
**a. Problem Recognition:** Requires excellent analytical ability, healthy group interactions and robust but correct documentation. Group movements would be excessive in and out of the solution space.

Relative velocity VP of individuals with respect to other individuals in the team would change quite frequently. At the same time mental feature vector is also of a high magnitude.

$V_P = V_P \pm \varphi_P$ ($\varphi_{P=}$ = Considerable variance, $V_P = {}^*$Relative velocity of the problem recognition phase)
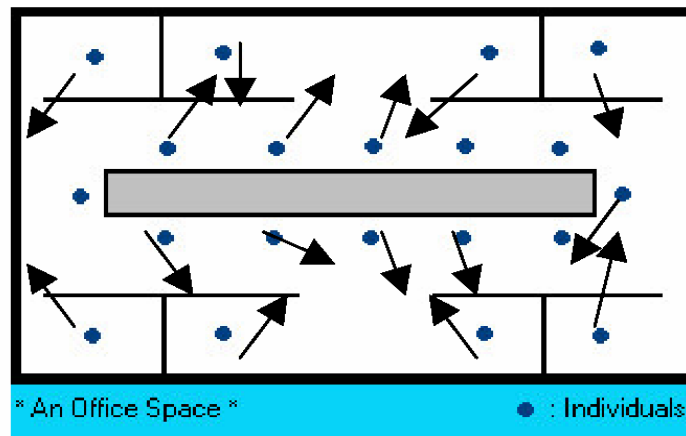
The model is illustrated in Figure 2 (a). During this phase the movement vectors (e.g. thinking process, decisive actions should be high) are exhaustive in nature so it should be a sum of considerable variance with initial relative velocity.

Figure 2 (a): Problem recognition phase scenario.
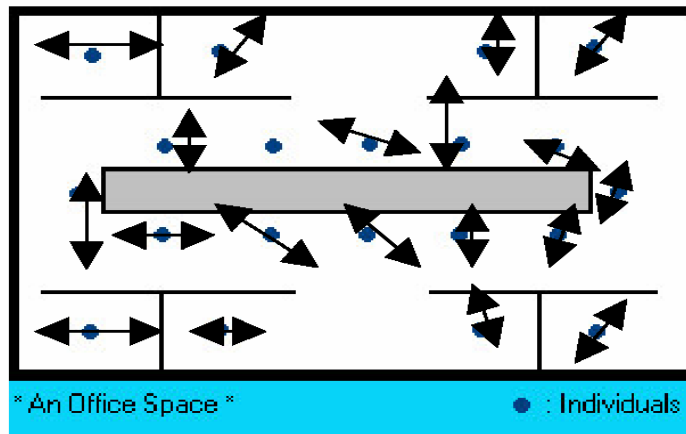
$$T = t_M - t_N$$

Figure 2 (b): Analysis phase scenario.

$$T = t_P - t_Q$$

b. Analysis: After the problem statement is prepared, each developer is expected to understand the problem/work at hand. The task is analyzed, checked, revised for feasibility, cost estimates, time estimates etc. Group movements in this phase could vary from time to time. Relative velocity VA of employees could remain constant, at a particular interval of time. Mental feature vector also varies, depending upon individual skill set. The process is illustrated in Figure 2 (b). The phase is relatively stable, mental movements of some members are high but not applicable for all the members. So group movements would be varying.

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* 'Relative velocity' from now on would imply relative velocity of individuals in the solution space

$V_A = V_A \pm \varphi_A$ (φ_A = Negligible deviation, V_A =Relative velocity of the analysis phase)
While at other intervals it could vary heavily,

$V_A = V_A \pm \varphi_A$ ($\varphi_A = \{\varphi_1, \varphi_2, \varphi_3, \varphi_4, \varphi_N\}$), where φ_A is a set of Considerable deviations.

c. Feasibility Study: Feasibility study would not deviate from the analysis dynamics.

d. Design: The design phase requires a very creative attitude of the developers at hand. So a very low velocity variance is expected with exceptional instantaneous increases. Developers should interact occasionally with each other in the solution space. Figure 3 demonstrates instantaneous changes in mental states (vectors) of the developer as in software design phase substantial amount of creativity is required. Group movements and physical movements are comparatively low, but individual's mental changes are visible.

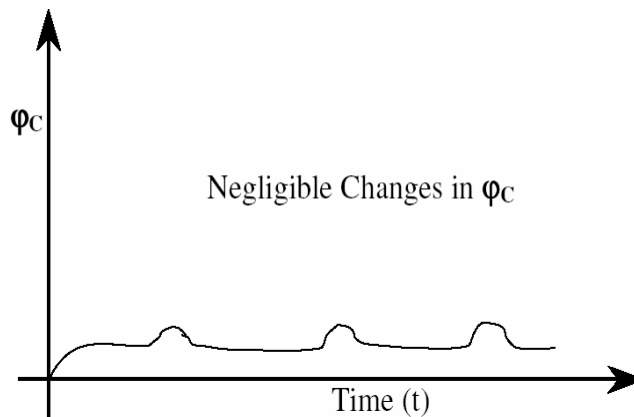**Figure 3:** Characteristics of mental state changes during design phase.
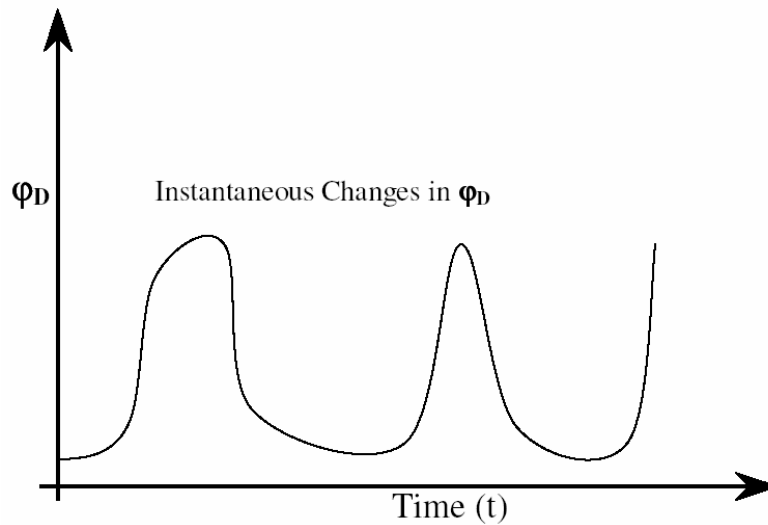

Figure 4: Attributes of mental states during coding phase.

$V_D = V_D \pm \varphi_D$ (φ_D = Considerable variance, V_D =Relative velocity of the design phase)

e. Coding: Coding phase requires flat typing in of the codes in a programming language based on the design parameters. Movements around the solution space would be relatively very low, but dynamics of mental vectors of the programmers are very high. Figure 4 exhibits the mental states of programmers while programming the SRS provided by the team leader, again group movement is low in magnitude and even it is variable with the types of coding platforms.

$V_C = K$ **(Constant)** $\pm \varphi_C$ (φ_C = Negligible variance, V_C =Relative velocity of the coding phase)

f. Testing: Testing requires/exhibits considerably few group movements (not negligible) as illustrated in Figure 5. Team members actively interact with associated active agents, to inter-relate their development so that premature errors could be sought out.

Figure 5: Testing attributes in mental state.
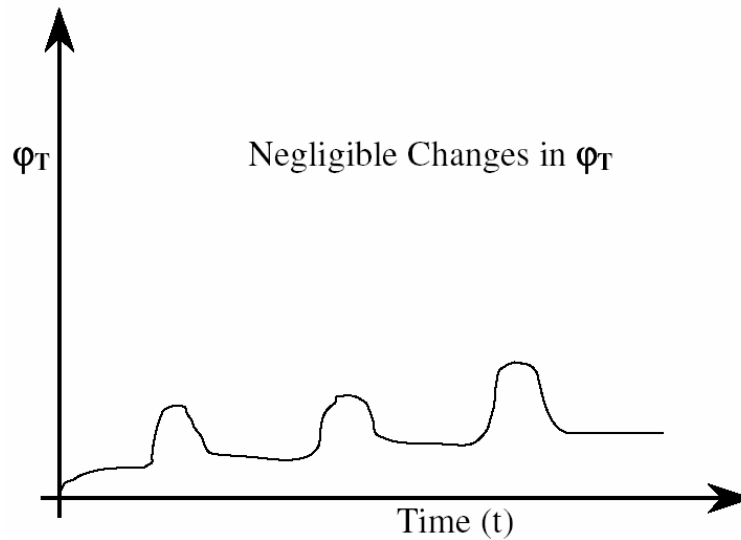
$V_T = K$ **(Constant)** $\pm \varphi_T$ (φ_T = Negligible variance, $\varphi_T > \varphi_C$, V_T = Relative velocity of the testing phase)

g. Implementation: It would correspond to the coding phase.

h. Post implementation/maintenance: It would correspond to the testing phase .The different phases and the various related metrics are summarized in Table1.

Table 1: Observable velocities of individuals in a space during software development

Phase	Metrics (Probabilistic)	Metrics (Optimal/Near Optimal)
Problem Recognition	$V_P = V_P \pm \varphi_P$ @ Varied "t"	$V_P = V_P \pm \varphi_P$ @ Regular "t"
Analysis	$V_A = V_A \pm \varphi_A$ @ Varied "t", Negligible φ_A	$V_A = V_A \pm \varphi_A$ @ Varied "t" $\varphi_A \to 0$ $\varphi_A = \{\phi\}$
Feasibility Study	Same as Analysis	Same as Analysis
Design	$V_D = V_D \pm \varphi_D$ @ Irregular "t"	$V_D = V_D \pm \varphi_D$ @ Occasional "t"
Coding	$V_C = K$ (Constant) $\pm \varphi_C$ @ Varied "t", Negligible φ_C	$V_C = K$ (Constant) $\pm \varphi_C$ @ Regular "t" $\varphi_C \to 0$
Testing	$V_T = K$ (Constant) $\pm \varphi_T$ @ Varied "t", Negligible φ_T $\varphi_T > \varphi_C$	$V_T = K$ (Constant) $\pm \varphi_T$ @ Regular "t" Negligible φ_T $\varphi_T > \varphi_C$
Implementation	Same as Coding	Same as Coding
Maintenance	Same as Testing	Same as Testing

Group Co-ordination and stigmergic Control

Stigmergy was introduced by studying (Parunak, 1997) biological insect societies and their concept of interaction and information exchange. Stigmergy describes a concept between software developers in a project mediated by an active environment. Investigation of biological insect societies shows that these animals coordinate themselves, producing a dissipative field in their environment. The interaction of ants is based on the existing of a smelling chemical substance called as pheromone. It is deposited by

the ants during their activities or tasks and modifies the communicative environment for all these following certain specific algorithms (Di Caro and Dorigo, 1998; Dorigo et al, 2000).

The different cognitive behavior of software developers as mentioned in previous section could produce a dynamic learning environment. The developer or agent's behavioral value largely differs in the pre or post scenario of a project. This is because, the agent interact among him or herself and reinforce where the maximum possibilities of gaining satisfaction out of these activities take place.

According to (Hanakawa et al, 1998) there are several piratical parameters to adjudge this chain relationship. In this present proposed system we confine the approach of stigmergy only to activity model of software project, which indirectly contributes in productivity and knowledge model. The activity model presents characteristics of activity, which are executed by a developer in project. Knowledge model presents characteristics of a developer. The productivity model presents the relationship between the activity and developer. The coordination of different members put an impact on the group inertia of the project.

Ideal Group Inertia for Software Development

Ideal solution could not be achieved in the practical system. So, one optimal or the most likely solution could be found out. A probable solution space may lead towards an optimal solution. This project proposes the dynamic chart for the group inertia related to software development. Let us consider each of the velocities, generated by individuals throughout the phases. Such a database would be huge and divided along the repositories of phases and dimensions. Not only mere positional velocities of individual but also accelerative velocities of project metrics or the factors determining the cost estimates of a project are interesting areas of exploration (Here velocity refers to any change in the measurable value of the metrics). The end results would like to indicate such repositories of velocities, behavioral and mental state displacement, calculate the resultant time interval required, to complete a phase and predict whether they are heading towards success, moderate success or failure.

Error Avoidance in Cost Estimates with Reference to COCOMO '81

A methodology is proposed for any avoidance of deviational variances from the optimal estimates computed by a particular model. The intermediate version of the COCOMO '81 database is chosen as the basis for our study (Boehm, 1981).The original intermediate COCOMO '81 database contains 63 projects. Each project is described by 17 attributes: the software size is measured in Kilo Delivered Source Instructions (KDSI); the project mode is defined as organic, semi-detached or embedded and 15 cost drivers as illustrated in Table 2, which are generally related to the software environment. Each cost driver is measured using a rating scale of six linguistic values. The assignment of linguistic values to the cost drivers (or project attributes) uses conventional quantization where the values are intervals. In this study, we will consider 13 of the Cost Drivers and their possible scaleable velocities as illustrated in Table 3.The scaleable velocities of the COCOMO'81 attributes are to be obtained from a regressed database of velocities divided along the repositories of the genre of attributes. Such regressed values ought to have an interval of error (ψ) as shown in Figure 6.

- A large positive value of ψ will render the project unsuccessful.
- A moderate positive value of ψ will render the project moderately successful.
- A negligible positive/negative value of ψ will render the project successful.

Table 2: Cost drivers of the intermediate COCOMO'81.

Attributes Product
RELY (Required Software Reliability)
DATA (Data Base Size)
CPLX (Product Complexity)
Attributes Material
TIME (Execution Time Constraint)
STOR (Main Storage Constraint)
VIRT (Virtual Machine Volatility)
TURN (Computer Turnaround Time)
VEXP (Virtual Machine Experience)
Attributes Personnel
ACAP (Analyst Capability)
AEXP (Application Experience)
PCAP (Programmer Capability)
LEXP (Programming Language Experience)
Attributes Project
MODP (Modern Programming Practices)
TOOL (Use of Software Tool)
SCED (Required Development Schedule)

Figure 6: Error factor from regressed database of velocities (movements).

$$\boxed{\textbf{V\_BASE}} \; ||| \; \boxed{\text{REGRESSION}} \Longrightarrow \; V_R \pm \text{'}\psi\text{'}$$

Table 3: Cost drivers and their scalable velocities.

	Velocity Notations	**Description**
RELY	V_{RELY}	Rate of change of RELY which might occur at later stages of the development phase.
DATA	V_{DATA}	Rate of change of DATA under unprecedented conditions.
CPLX	V_{CPLX}	Rate of change of CPLX due to unavoidable conditions as erroneous designing of the system .
TIME	V_{TIME}	Rate of change of TIME due to latest customer requirements or emergency.
STOR	V_{STOR}	Rate of change of STOR due to unprecedented breakdowns as power failures, virus attacks etc.
TURN	V_{TURN}	Rate of change of TURN due to dynamic overheads.
ACAP	V_{ACAP}	Rate of change of ACAP due to latest integrative studies.
AEXP	V_{AEXP}	Rate of change of AEXP due to latest accomplishments.
PCAP	V_{PCAP}	Rate of change of PCAP due to recent change in mental state.
LEXP	L_{EXP}	Rate of change of LEXP due to latest accomplishments.
MODP	V_{MODP}	Rate of change of MODP due to momentary popularity of practices etc.
TOOL	V_{TOOL}	Rate of change of TOOL due to unavoidable reasons.
SCED	V_{SCED}	Rate of change of SCED due to emergency or preponed deadlines.

Analysis Using the Proposed Model

The behavioral presentation in any model of Software Development Life Cycle (SDLC) is primarily monitored through the block of attribute personnel. We used this model to represent the mental state of the programmer/analyst capability. Suppose that the developer in the group has successfully completed his assignment, and his contribution influences the project inertia in the following ways, which could be considered as fuzzy linguistic variables:

X_1: Simple/standard behavior during coding.

X_2: Exhibited certain reservation towards leader's instructions, not followed SRS properly.
X_3: Took extra time, but completed the job, if any lapse, suppressed by group.
X_4: Got assistance of other members.
X_5: Completed whole project in a light and daily schedule without extra time assistance from others.
X_6: Completely exactly what had been asked for with pleasure.

Assume that the developer has the expectation of the group inertia represented by the possibility distribution

R_o = (0.9, 0.1, 0.7, 0.3, 0.1, 0.6)

We can see from this distribution that the developer expects a positive inertia, may be he/she needs help from the group. If overall, the o/p inertia, for the other members become,

$E_1 = 0.1/x_1 + 0.8/x_2 + 0.4/x_3 + 0.7/x_5$

This inertia replicates although relatively strong, unambiguous and clear is rather inconsistent, with the developer's expectation about his group.

Let, $S(M, r) = \max[\min(\mu_M(x), r(x))]$
$x \in Z$.

Corresponds to the received message with possibilistic expectations
$S(M_1, r_o) = (0.1, 0.1, 0.4, 0.1) = 0.4$.

Because this outcome is contrary to the developer's real expectation, let us assume by virtue of human behavior, he wants to add some distortion.

As equation, $\mu(x) = \mu^S \mu(x)$
Such that it likely,
$\mu_1' = 0.4/x_1 + 0.9/x_2 + 0.7/x_3 + 0.4/x$

The already proposed model (Helbing, 1991) as such consists of three sub-modules namely activity, productivity and knowledge model. Here, we can map knowledge model into attribute personnel, which clearly demonstrates uncertainty:

$$L_{ij}(\varphi) = W_j \begin{cases} K_{ij} \times e^{-E_{ij}(\varphi - b_{ij})}, & b_{ij} < \varphi \\ 0, & b_{ij} > \varphi \end{cases}$$

where, $L_{ij}(\varphi)$ = quantity of gains to knowledge of a developer i by executing a primitive activity of activity j which has a knowledge level 'φ'.
b_{ij} = developer i's knowledge level about activity j.
E_{ij} = developer i's downward rate of gain to knowledge by executing activity j.
φ : Required knowledge level to execute the primary activity of activity j.
w_j : Total amount of activity j.
K_{ij} : Maximum quantity of gains to knowledge of developer i by executing activity j.

The K-model presents characteristics of a developer, his willingness to learn, transparency of behavior, sustainability to deadline, abiding to project authority, etc. Considering these aspects an additional complication is introduced when we consider that the software developer may also introduce distortion in the message because with the inconsistency with the expectation, Let

$S(M, r) = \max[\min(\mu_M(x), r(x)]$
$x \in X$

Correspond the consistency of the receive message which the receiver actually hears as M',
where, $(\mu_M(x) = (\mu^S_M(x)$
for each, $x \in X$.

The less consistent M with the expectation the less M' resembles M. Since the receiver will be modifying his/her expectations to perform, the new possibilistic expectation structure is given by: $r_1(x) = \min[r_o^{1-S}(x), \mu_M'(x)$, for each $x \in X$. Now as measured by (1) the consistency is $s(M_1, r_o) = \max[0.1, 0.1, 0.4, 0.1) = 0.4$

Because the message is contrary to the developer's expectation; let us assume that he introduces some distortion as we mentioned in, such that the message he hears it:

$M_1' = 0.1/x_1 + 0.9/x_2 + 0.7/x_3 + 0.4/x_5$

Based on this message he modifies his expectation such that

$r_1(x) = \min [r_o^6(x), \mu M_1'(x)]$

for each $x \in X$ or

$r_1 = 0.4/x_1 + 0.25/x_2 + 0.7/x_3 + 0.25/x_5$

The developer has then experienced greatly diminished negation and his expectation of a simple derisive laughter of the group has given up all hope of the possibility of joy and confidence.

Suppose now that in disbelief, the programmer asks the project leader to repeat the judgment and receives the following message: $M = 0.9/x_2 + 0.4/x_5$

This message is stronger, clearer and less general than the first answer. It's consistency to the developer's new expectation is (of his performance or contribution), $S(M_2, r_1) = .25$. Thus the message is highly contrary even to the revised expectation of the developer. So let's suppose that he distorts the message such that he hears, $M_2' = 0.97/x_2 + 0.8/x_5$. His surprise has then diminished the clarity of the message heard and has lead him to exaggerate the degree to which he believes that the project leader has not responded well, he responded with derisive laughter. Now let us suppose that the response which the developer makes the following characteristics from the following set y, which is mapped with fuzzy linguistic variables as well:

y_1 = Happily completed, under the guideline of project leader.
y_2 = Not happy at the end of the project.
y_3 = Surprised about his own good/bad performance.
y_4 = Anger/frustration for not to contribute.
y_5 = Patient and confident but less happy, about the group support.
y_6 = Impatient and asks to change the group.
y_7 = Ability to learn more.

Let the fuzzy relation $R \in y \times x$ represent the degree to which the programmer plans to respond to a given signal x with a response having the attribute y. Their relations are given in Table 4.

Table 4: Relationship between programmer plans to a given signal.

	X_1	X_2	X_3	X_4	X_5	X_6
Y_1	0.9	0	0.2	0	0	1
Y_2	0	0.9	0.1	0.2	1	0
Y_3	0.1	0.9	0.2	0.9	1	0.3
Y_4	0	0.5	0	0.6	0.7	0
Y_5	0.1	0	0.9	0	0	0.5
Y_6	0	0.3	0.2	0.3	0.4	0
Y_7	0.9	0	0.9	0.3	0	1

$\mu_A(y) = \max [\min (\mu_r (y, x), \mu_M(x)], x \in X.$

Based on this we can now calculate the response which the developer will make to the message M_2':

$A = R_o M_2' = 0.9/y_2 + 0.9/y_3 + 0.7/y_4 + 0.4/y_6$

The developer's response therefore will have the characteristics of a great deal of frustration and surprise, a large degree of anger and some impatience.

## A Decision Tree for Steering a Project to Success

A decision tree as illustrated in Figure 7 is proposed to help in minimizing the 'ψ' value. special nodes namely ARNs (Administrative Root Nodes) are employed, which govern the weight factors (depicted

in Table 5), assigned to their respective child nodes. Weights assigned to branches get incremented by a unit value if a momentary increase in the velocity refresh rate is experienced by a particular ARN node. The responsibility of the ARN now would be to constantly recommend velocities as required so that the 'ψ' value could be kept a minimum. As the prototype of the project is meant for the development of Virtual Project Leader (VPL), therefore, the level of decisions (or decision tree) based on the behavior and mental state of individual members can be configured. Actually, the cumulative effect of such attribute affects the whole project.

Table 5: Conditions to be maintained for avoiding erroneous deviation from cost estimates.

Concerned Cocomo'81 Attributes	Maintainable conditions
Attributes Product	$V_{DATA} < V_{CPLX} < V_{RELY}$
Attributes Material	$V_{STORE} < V_{TURN} < V_{TIME}$
Attributes Personnel	$V_{ACAP} < V_{PCAP} < V_{AEXP} < V_{LEXP}$
Attributes Project	$V_{TOOL} < V_{MODP} < V_{SCED}$

Figure7: Decision tree model.
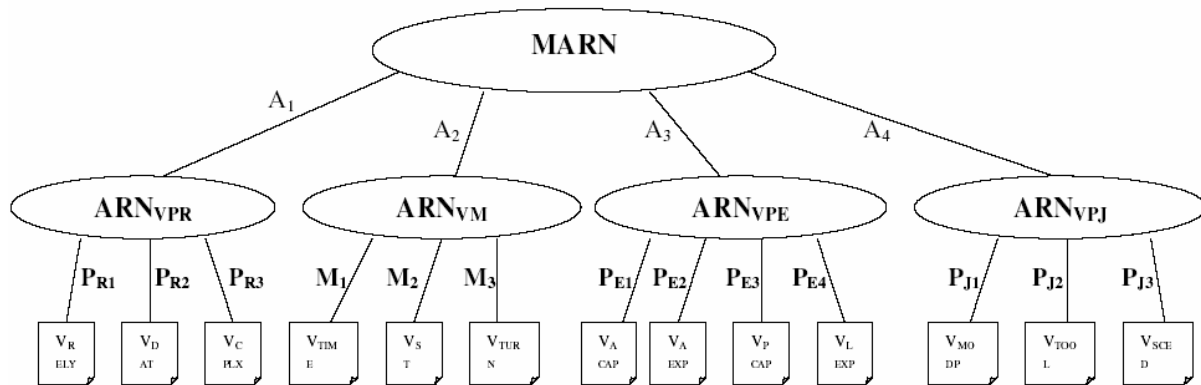
The MARN (Master Administrative Root Node), decides priorities of weights in a function COMP (ω, PHASE, n (ω)),ω is a set of weights sent to COMP for comparison. PHASE refers to a particular phase in SDLC.

Here, COMP = (A, PHASE$_X$, 4) = $A_1 < A_2 < A_3 < A_4$

The cardinality factor n(ω) refers to the fact that the proposed model also welcomes any further increase in attribute genres in the COCOMO' 81 models.

Conclusions and Future Research

In practice, nowadays the IT industry largely follows, object-oriented paradigm irrespective of the status of the project. In all the cases, programming is the basic implementation of any software development life cycle, which again depends on individual psychology of the programmer. This paper presented an analytical method to model and analyzes such behavior in tune of project leader's dynamics, group dynamics etc. and thus could extrapolate the possibility of success or failure of the project and lead to stigmergic coordination, where agents collaborate collectively to accomplish a defined task. If the project gets similar attributes in the future, then it may be feasible to apply the acquired behavioral attributes to execute the project. In this context the concept of virtual project leader can be introduced for future development.

References

[1]   Ali I. and Alain A. (2001) A Fuzzy Logic Based Set of Measures for Software Project
        Similarity: Validation and Possible Improvements, 7th IEEE International Software Metrics
        Symposium, IEEE Computer Society, pp. 85-97.
[2]   Boehm B. (1981) Software Engineering Economics. Prentice Hall.
[3]   Di Caro G., Dorigo M. (1998) Ant Net –Distributed Stigmergic Control for Communication
        Networks, Journal of AI Research 9.
[4]   Dorigo M., Bonabeau E. and Theralaz G. (2000) Ant Algorithm and Stigmergy, Future
        Generation Computer System 16 No.08, pp 851-956.
[5]   Eysenck M. W. and Keane M.T. (1990) Cognitive Psychology, A Student's Rawbook.
[6]   Gary R., George and Cardullo F. (1999) Research paper on, Application of Neuro Fuzzy
        System   to   Behavioral   Representation   in   Computer   Generated   Forces,
        http://citeseer.ist.psu.edu/george99application.html.
[7]   Gray W. D., Schoelles M. J. and Fu W.T. (2000) Modeling a Continuous Dynamic Task,
        Proceedings of the 3rd International Conference on Cognitive Modeling, pp. 156-168.
[8]   Hanakawa N, Ken-ichi M. and Torii K (2002) A Knowledge-Based Software Process
        Simulation Model, Annals of Software Eng. 14(1-4): 383-406.
[9]   Hanakawa N, Ken-ichi M, Katsuro I, and Torii K (2000) A Software Development Simulation
        Model based on Dynamic Changes in Developer's Knowledge Structure, International
        Workshop on Software Process Simulation Modeling, England.
[10]   Hanakawa N, Morisaki S and Ken-ichi M. (1998) Application of Learning Curve Based
        Simulation Model for Software Development to Industry, In Proc. 20th International Conference
        on Software Engineering, pp. 350 – 359.
[11]   Helbing D. (1991) A Mathematical Model for the behavior of Pedestrians, Behavioral Science,
        36, 4, pp. 298-310
[12]   Kurosu K., Furuya T., Nakamura M., Utsunomiya H. and Soeda M. (1992) Dynamic and Fuzzy
        Control of a Group, IEEE International Workshop on Emerging Technologies and Factory
        Automation, pp. 572-577.
[13]   Morisio M. (2000) How to Study Individual Programmers, In Proceedings of 22nd International
        Conference on Software Engineering, Ireland, http://citeseer.ist.psu.edu/684393.html.
[14]   Moström J.E. and Carr D. (1998) Programming Paradigms and Program Comprehension,
        Proceedings of the 10th Annual Workshop of the Psychology of Programmers Interest Group,
        UK, pp. 117-127.
[15]   Musse S.R. and Thalman D. (1997) Computer Animation and Simulations, Proceedings
        Eurographics workshop, Budapest Springer Verlag, pp. 39-51.
[16]   Parunak H. V. D. (1997) "'Go to the Ant': Engineering Principles from Natural Agent
        Systems," Annals of Operations Research, vol. 75, pp. 69-101
[17]   Zaphiris P., Kurniawan S.H. and Ellis R.D. (2003) Mathematical Formulation of Age Related
        Differences in Mouse Movement Tasks. In C. Stephanidis (Ed.), Universal Access in HCI,
        Lawrence Erlbaum, USA, pp. 917-921.

The Influence of the Second Fusion on the Microstructue and Electrochemical Behaviour of Algerian Zinc

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Abstract

Zinc from the Algerian metallurgy industry (zinc A) was compared with specimens of the same zinc following fusion treatment at 500°C for 60 minutes and cooling according to three different kinetics. The treated materials are designated by B, C, and D. The fusion/cooling treatment modified the microstructural state of the metal. The different microstructural states were revealed by X-ray diffraction.

Electrochemical studies of the treated zinc specimens were performed using voltammetry, potentiometry and electrochemical impedance spectroscopy (EIS). Only a significant variation in EIS results was found. The EIS diagrams of the materials varied with immersion times. The variations in low frequency resistance were directly correlated with the microstructural states of the specimens. The results of the study indicate that fusion treatment at 500°C for 60 minutes and cooling by nitrogen to $10 \, l \, min^{-1}$ is the most suitable for use as a sacrificial anode.

Key words: zinc; sacrificial anode; corrosion; oil storage tank; electrochemical impedance
spectroscopy.

Introduction

Storage tanks in carbon steel are subject to corrosion even when the insides are protected with an epoxy resin coating. Over time, the protective coating starts to deteriorate and the carbon steel comes into contact with the corrosive environment. Localized corrosion then occurs, and holes quickly start to form in the bottom of the tanks. To prevent this situation, additional cathodic protection can be provided by means of zinc based sacrificial anodes.

Cathodic protection involves reducing the potential of the metal structure to be protected to a value at which corrosion is negligible. This is achieved by the passage of an electric current created

when a metal structure is coupled with a sacrificial anode. Tanks are checked periodically to determine the extent of corrosion[1,2].

Cathodic protection shifts the corrosion potential of the carbon steel tank bottom towards more negative values, making corrosion thermodynamically impossible[3]. Biofilms formed in the presence of bacterial activity do not affect the electrical properties of zinc anodes, making them particularly suitable for protecting the bottoms of oil storage tanks[4].

Zinc anodes are well suited to the protection of metal structures exposed to salt or sea-water electrolytes and buried metallic structures in the soil. They are reliable irrespective of the current flow, and even after long periods of inactivity[5]. They are highly resistant to fouling and provide very good faradic yield. Their applications include the protection of short-length buried pipes and the protection of immersed structures such as ship hulls and carbon steel tanks (inside and outside) [6, 7,8].

The properties of sacrificial anode are related to zinc composition [9]. The alloying with elements such aluminum decreases corrosion where as iron impurity promotes zinc corrosion.

In many cases, the metallurgical effects can contribute to localized corrosion – intergranular corrosion which can be observed on the surface in various environments.

In order to investigate the possibility of improving the electrochemical properties of zinc, experiments were carried out on zinc obtained from the Ghazaouet facility in Algeria.

The zinc was subjected to fusion at 500 °C for 60 minutes and specimens were then cooled according to three different cooling kinetics in order to alter their structural state. The specimens thus obtained were designated by the letters B, C, and D. The purpose of our study was to determine the variation in electrochemical properties of the zinc sacrificial anodes as a function of their different microstructural states.

Experimental Methods
2-1 Chemical analyses

Two types of zinc anodes are described in the literature. One is 99.99% pure zinc which provides a high current flow. It is recommended for protecting structures in soil, in brine and in freshwater. The second type is a zinc alloy containing 0.1 to 0.5% aluminium and 0.03 to 0.1% cadmium. It is used to obtain higher amperage in sea water. The Algerian zinc (A) used for our experiments was of the second type. The chemical composition of this material is given in Table 1. In addition to the basic element Zn it contains an appreciable amount of Al (1.06%). It also contains trace elements of lead and iron, the concentrations being below 10 ppm [10,11,12]. The open circuit potential is approximately - 1.046 V/SCE in the drainage water (table 2) sampled from the bottom of the carbon steel oil storage tank [13].

Table 1: Chemical composition of zinc A as delivered.

Element	Zn	Al	S	Ti	Fe	Pb
(wt %)	98.8 ± 2.3	1.06 ± 0.05	0.008 ± 0.002	0.0066 ± 0.0006	< 10 ppm	< 10 ppm

Table 2: Chemical composition of electrolyte (drainage water).

Ion	Ca++	Mg++	Fe++	Na+	K+	Cl-	SO4--	NO2-
Conc. (m equ. l^{-1})	230.83	45.00	7.02	400.17	7.67	678.47	2.08	3.58

2.2 Fusion treatment of zinc A

The fusion treatments were performed in controlled atmosphere and a low vacuum of 10^{-2} mbar. Graphite molds were used for the procedure. Each mold was composed of four cylinders of 12 mm in

diameter and 40 mm long. The zinc A chips were placed in the upper chamber of the mold and fused at 500°C for one hour. The first specimen, zinc B, was then cooled by nitrogen introduced into the furnace at a rate of 10 l min^{-1}.

The second specimen, zinc C, was cooled with nitrogen at a flow rate of 2 l min^{-1}. The third specimen, zinc D, was left to cool slowly in the furnace at a low vacuum of 10^{-2} mbar to prevent oxidation of the material. The specimens prepared for the metallographic analyses and electrochemical measurements were circular, 12 mm in diameter and 10 mm thick. The working electrodes were mechanically polished with wet abrasive paper of increasingly finer grit: 120, 240, 620, 800 and 1200. They were then washed in water, rinsed in acetone and used immediately.

The metallographic analysis was performed with a METALLUX 3 optical microscope and microhardness was measured with a LEIKA microhardness tester. Grain density was analysed using the Analysis 3.1 image analyser and the microscope.

2.3 Electrochemical study

The electrochemical measurements (corrosion potential, voltamperometry and electrochemical impedance spectroscopy-EIS) were performed at room temperature. The electrolyte was drainage water taken from an oil storage tank at the In Amenas oilfield in Algeria. The chemical composition of this water is shown in Table 2, sodium chloride was the major element in this water. To make the working electrode, an electrical wire was welded to one end of the electrode (ZincA, B, C and D) used for the electrochemical measurements and these assemblies were then coated with a thermosetting resin. The electrochemical set-up consisted of an EGG PAR Instrument 273A potentiostat/galvanostat and a Solartron1255 frequency response analyser. Solartron's Zplot and Zview software and ECG M352 were used for data acquisition and processing. The linearity and stationary state of the system was verified.

Results and Discussion
3.1. Metallographic and crystallographic analysis

The metallographic analysis of zinc specimens A, B, C and D revealed a difference in the microstructural state of the materials. The micrograph of zinc A in the state take it of from the Ghazaouet facility in Algeria is shown in figure 1. It is characterized [13] by the presence of coarse elongated grains with different contrasts (due to the crystallographic planes) varying between dark to light under the effects of incident light. This structure also includes needle-shaped platelets often starting from the grain boundaries and going in random directions.

Figure 1: Metallographic structure of zinc A,- Corroding agent 20 g Cr_2O_3, 1.5 g Na_2SO_4 in 100 ml H_2O.
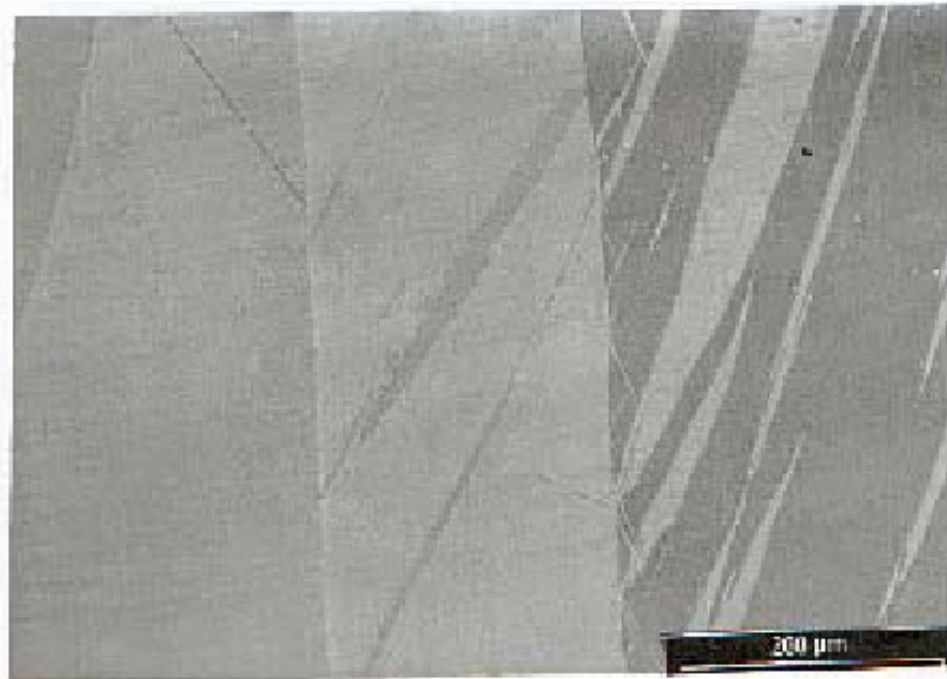
The metallograph confirms the formation of relatively fine grains (figure 2), compared with the microstructure of zinc A. The needles seen on the metallograph of zinc B are caused essentially by rapid recrystallisation which results in a preferential orientation of the grains.

Figure 2: Metallographic structure of zinc B, cooled with N_2 -10 l/min. Corroding agent 20 g Cr_2O_3, 1.5 g Na_2SO_4 in 100 ml H_2O.

The micostructures of zinc C and D are characterised by the formation of irregular sized grains. The metallographic analyses (figures 3 and 4) of these specimens revealed in both cases the presence

of finer needles than those of zinc B, also caused by excessively fast recrystallisation and preferential orientation of the grains.

Figure 3: Metallographic structure of zinc C, cooled with N_2 - 2 l/min. Corroding agent 20 g Cr_2O_3, 1.5 g Na_2SO_4 in 100 ml H_2O
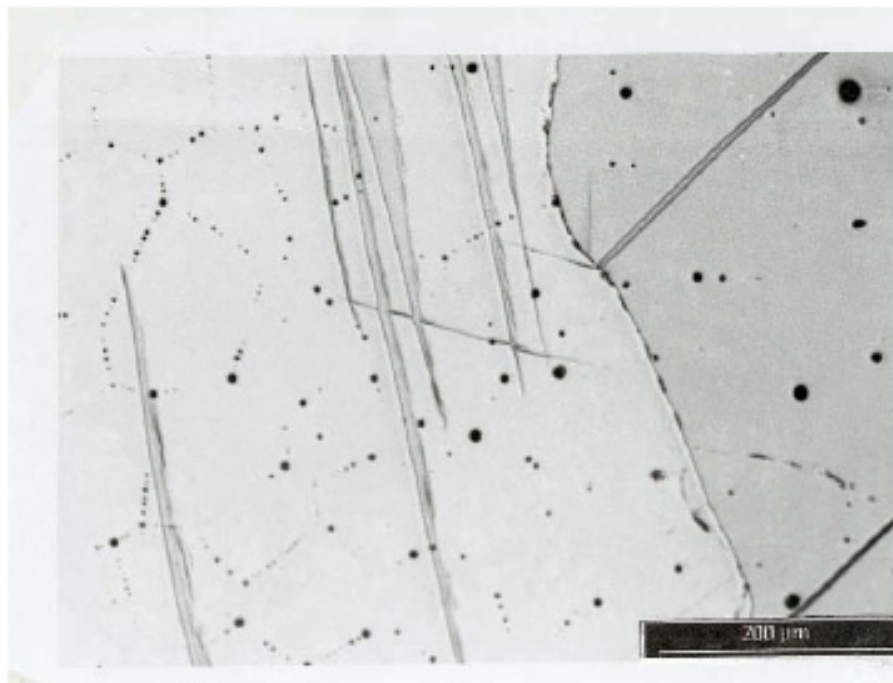
Figure 4: Metallographic structure of zinc D, cooled with N_2 – 2 l/min. Corroding agent 20 g, Cr_2O_3, 1.5 g Na_2SO_4 in 100 ml H_2O.
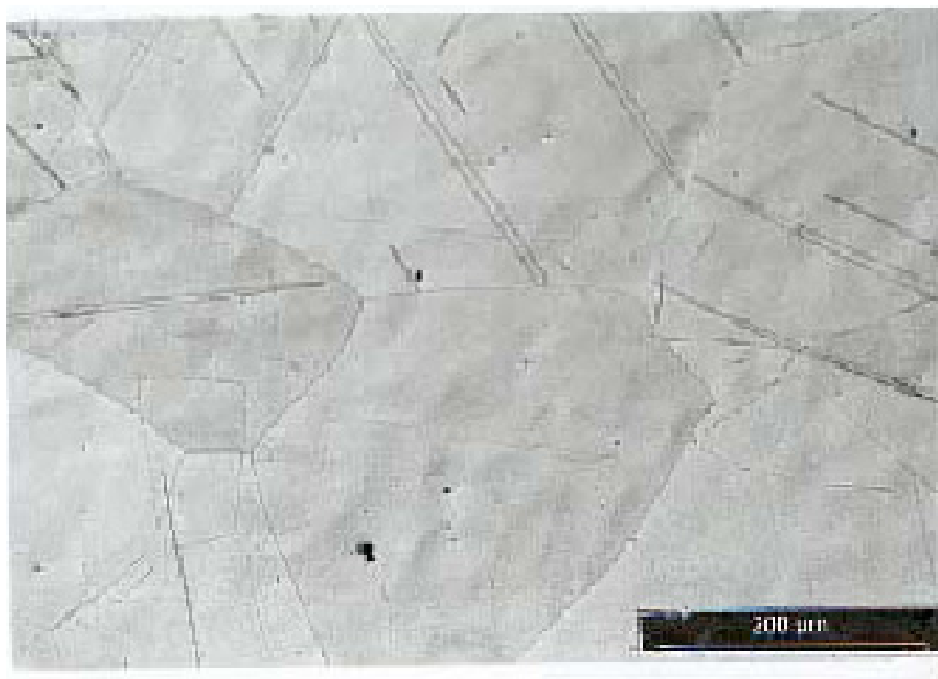
The diffractometric study (figure 5) revealed an appreciable difference in the position and intensity of the lines. The diffraction peaks (002) and (100) of zinc B are intense and shift towards the left compared with those of zinc A, for which the most intense peak is (101). This shift of the peaks to the left can be explained by an increase in the inter-reticular distances. This variation is caused by an

increase in the parameters due to dissolution of the elements (Al, Ti, Fe,…) trapped in the grains during nitrogen cooling at 10 l min-1. The diffractograms of zinc C and D present no particular features in terms of the position of the planes of the first lines (002), (100) and (101). On the other hand, the intensity of line (110) of zinc C and the intensity of the planes (002) and (101) of zinc D confirm that the three cooling kinetics caused preferential orientation of the grains in a different way. This confirms the orientation of the coarse needle-shaped grains on the metallographs in figures 3 and 4. Table 3 compares the first nine lines of ASTM sheet N°4-0831 with those of zinc A, B, C and D. This table indicates the most intense diffraction planes corresponding to the values of d(hkl). It is important to note that the most intense peaks of zinc B are (002) for d(hkl) = 2.475 Å, and (100) for d(hkl) = 2.317 Å, whereas the standard d(hkl) values in the ASTM sheet for these same planes are respectively 2.471 Å and 2.309 Å. It can be seen that for zinc D, the d(hkl) values are closer to the standard d(hkl) values and to those of zinc A due to the microstructural state obtained after cooling in the furnace.

Figure 5: X ray diagrams of zinc A, B, C and D
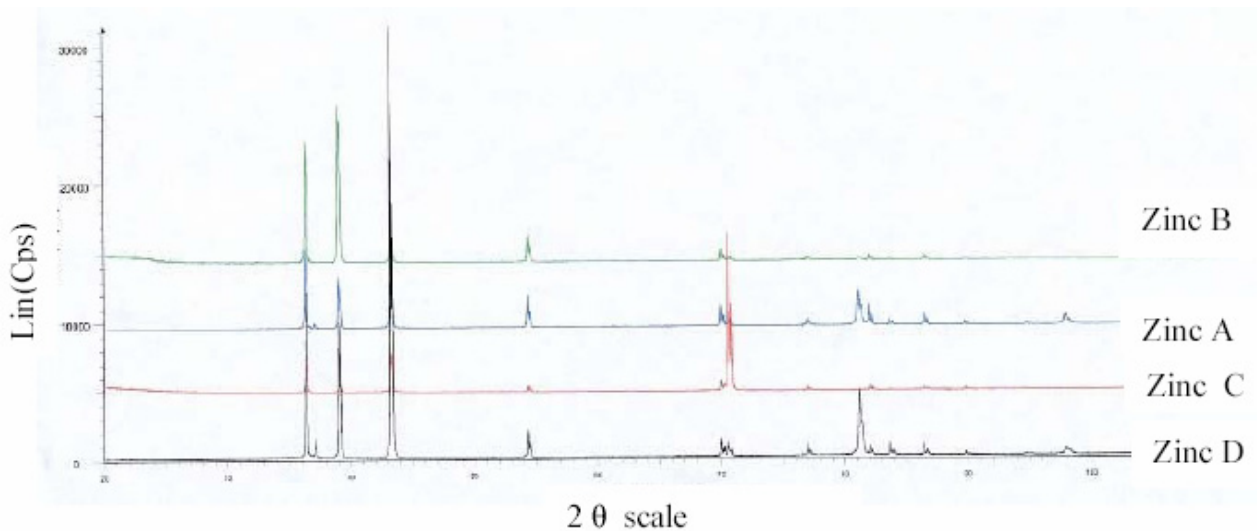
Table 3: d(hkl) values given in ASTM sheet n° 4-0831 and d(hkl) values for zinc A, B, C and D

| Line number	ASTM index (hkl)	Sheet N° 4-0831 D(hkl)***	Zinc A	Zinc B	Zinc C	Zinc D
1	(002)	0.2473	0.2471	0.2475*	0.2471	0.2475*
2	(100)	0.2308	0.2309	0.2317*	0.2309	0.2209
3	(101)	0.2091	0.2094*	0.2084	0.2094	0.2094*
4	(102)	0.1687	0.1690	0.1690	0.1169	0.1688
5	(103)	0.1342	0.1344	0.1344	**	0.1344
6	(110)	0.1332	0.1334	0.1330	0.1333*	0.1332
7	(004)	0.1237	0.1238	0.1237	0.1238	0.1237
8	(112)	0.1173	0.1174	0.1174	0.1172	0.1174
9	(200)	0.1154	0.1156	0.1154	**	0.1154

*   the most intense
**   No peak
***   nm

3.2 Microhardness measurements

Microhardness measurements were made on longitudinal sections from zinc A, B, C and D. The microhardness values for zinc B, C and D, which were treated by fusion, were slightly higher than those measured on zinc A. The difference in microhardness between zinc A, B, C and D is shown in

figure 6. Hardening of the zinc B, C and D was caused by release into solid solution of the impurities in the grains. The microhardness of zinc A was virtually uniform along the section, clearly indicating a homogeneous crystalline structure. The fluctuations in microhardness recorded for zinc B, C and D indicate the presence of heterogeneities in the crystalline structures. These results are in agreement with those shown by the micrographs.

Figure 6: Micro-hardness (Hv) of zinc A, B, C and D
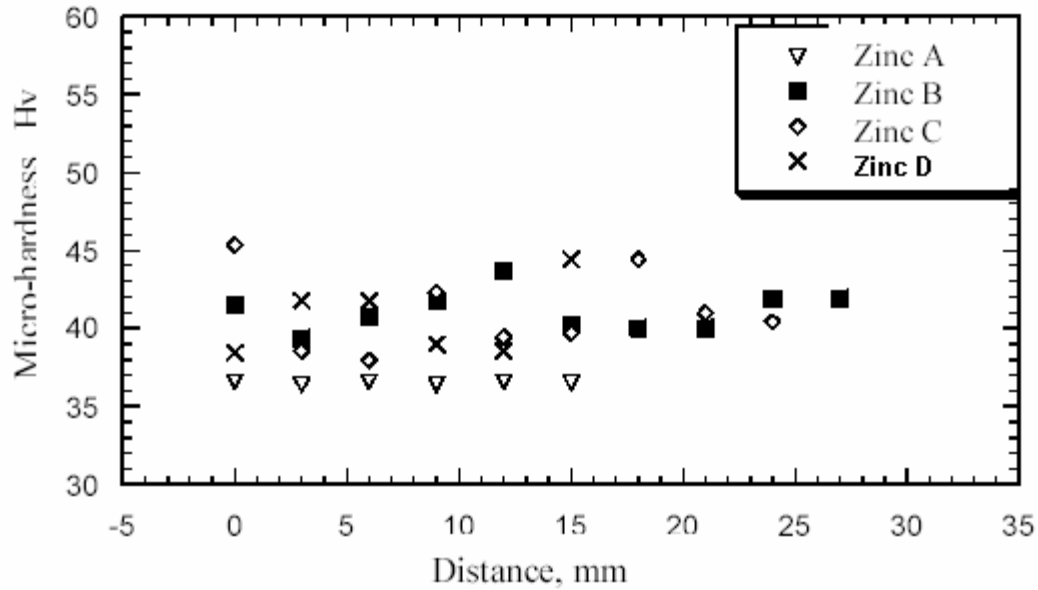
3.3 Electrochemical measurements

3.3.1 Corrosion Potential
Changes in the corrosion potential of the four zinc A, B, C and D as a function of immersion time are shown in figure 7. The potential - of the four specimens - increased with immersion time, indicating the formation of corrosion products on the surface of the metal.

Figure 7: Corrosion potential of zinc A, B, C and D in drainage water.
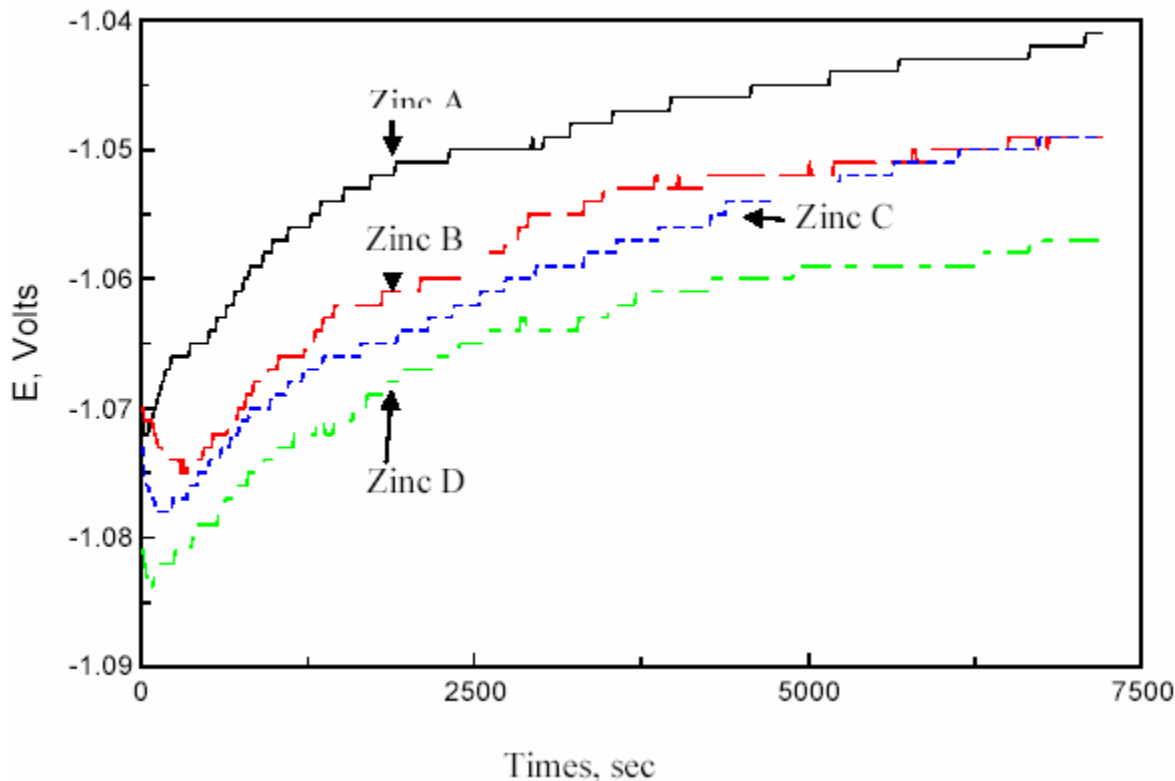
The corrosion potentials of these different materials measured in the drainage water (table 2) of an oil storage tank after 2 hours immersion were similar, namely -1.041, -1.049, -1.049 and −1.053 V/SCE respectively for zinc A, B, C and D [13].

This observation suggests that the fusion treatment did not have a significant impact on zinc activity, which is consistent with the chemical composition of the specimens A, B, C, and D.

3.3.2 Linear potential scan voltamperometry

The polarisation curves obtained with the electrodes are shown in figure 8. Two particular characteristics should be noted. The first is the low polarisation in the potential range around − 1000 mV/SCE and for current densities below 0.4 µA cm^{-2}. The second is that in the potential range above −50mV/ SCE, the dissolution current density was independent of the applied potential. The limiting value was around 0.5µA cm^{-2}. A layer of corrosion products formed on the surface of the electrode. No significant difference in measurements was observed between the different specimens A, B, C and D.

Figure 8: Polarization curves of zinc A, B, C and D in drainage water. Scanning rate = 1mV s^{-1}.
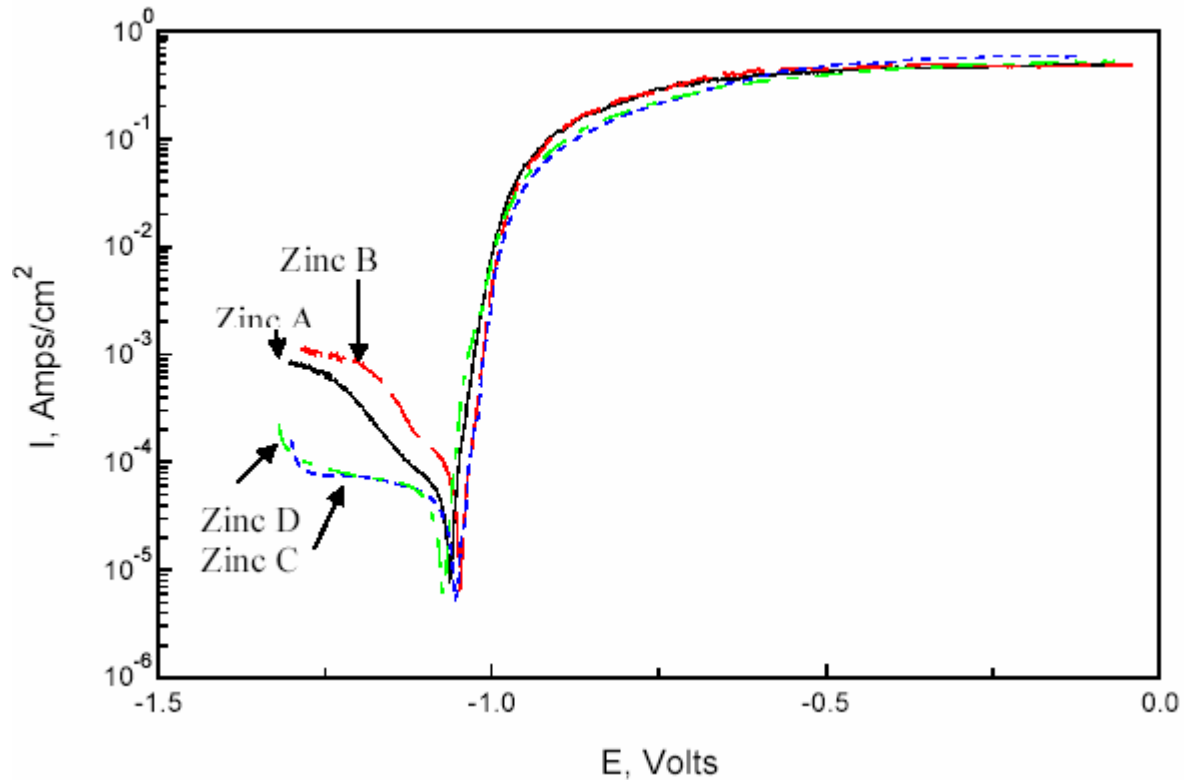
3.3.3 Potentiostatic polarisation measurements

Potentiostatic polarisation tests were performed to compare the dissolution activity of the different materials. The applied potential for zinc A, B, C and D was slightly anodic compared with the corrosion potential, that is $E_{app.} = E_{corr} + 10$ mV. Changes in the dissolution current density of the four specimens - zinc A, B, C, and D - over time are illustrated in figure 9. After 1000 sec immersion, the current densities of zinc A, B, C and D were 69, 213, 579 and 330 $\mu A/cm^2$ respectively. It can be seen that the activity of zinc A was slightly lower than that of zinc B, C and D which had undergone a second fusion treatment.

Figure 9: Potentiostatic curves of zinc A, B, C and D in drainage water at Eapp = Ecorr + 10 mV
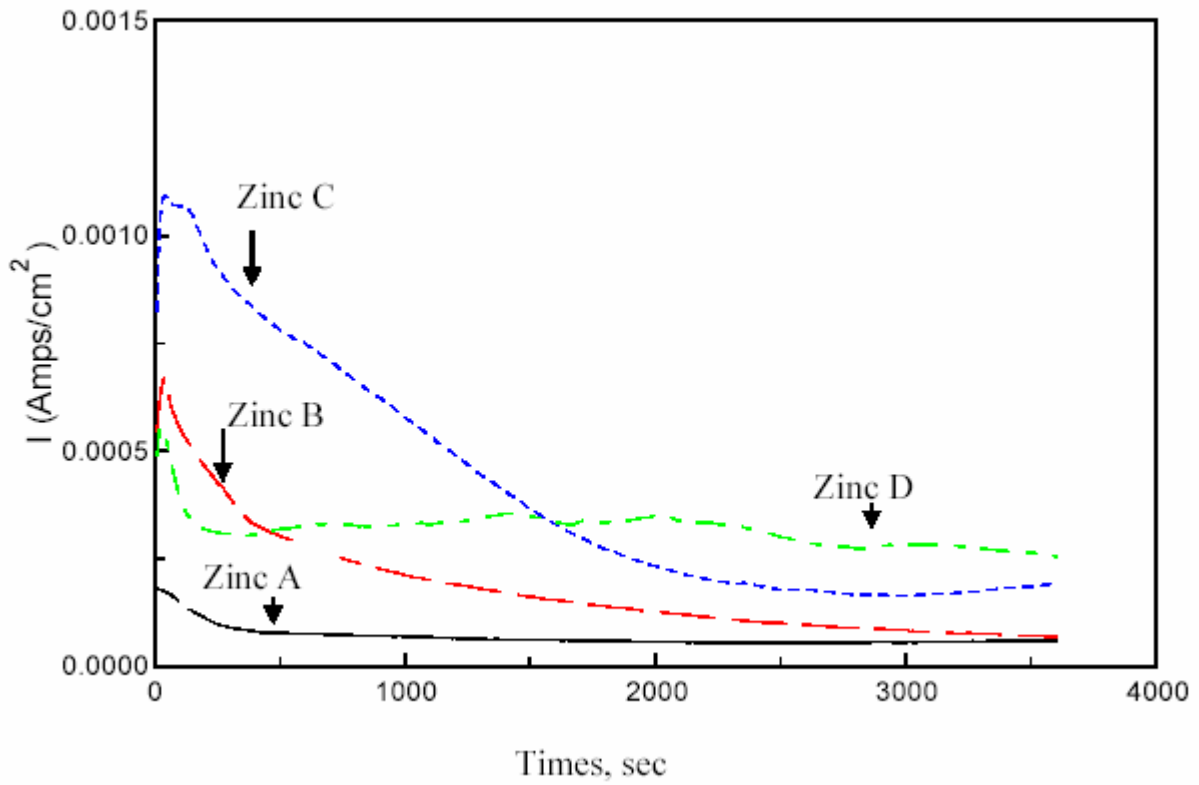
3.4 Electrochemical impedance spectroscopy (EIS) measurements

EIS measurements for the four materials zinc A, B, C, D were performed at the corrosion potential after different immersion times: 0.5, 1, 3, 7 and 11 hours. The impedance diagrams are shown in the Nyquist and Bode form.

With the zinc A (figure 10), the impedance diagrams evolved as a function of immersion time in the electrolyte.

Figure 10: Electrochemical impedance spectroscopy at different immersion times in drainage water for zinc A. - Measurements performed at corrosion potential. Nyquist and Bode diagrams.
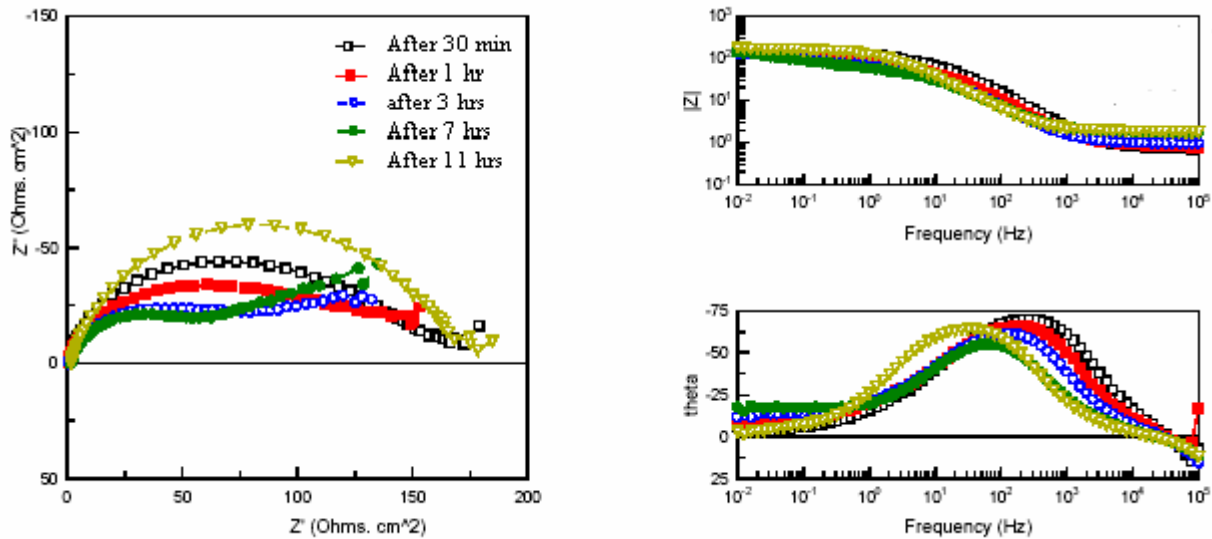
- After 0.5 hr immersion, a capacitive loop that is off-centre compared with the real axis can be observed on the Nyquist diagram. According to the literature [14], low frequency limit resistance (<1Hz) -similar to polarization resistance - (Rp) can be estimated near to 200 .Ω cm^2 and high frequency limit resistance (>100Hz) -similar to electrolyte resistance (Re) near to 1. Ω cm^2 (Bode diagram).

- After 1 hour immersion, the capacitive loop becomes flatter and much more off centre on the Nyquist diagram, Rp decreased.

- After 3 hours and 7 hours immersion, there is a discontinuity at low frequencies: two parts can be observed on the Nyquist diagram. At high frequencies (>100Hz), the capacitive loop should be attributed to the corrosion layer (CPE1, R$_f$), the double layer and electronic charge transfert (CPE2, R$_t$). At low frequencies (<1Hz), a linear part at around 45° is obtained, corresponding to the diffusion term of the electrolyte across the corrosion layer according to the literature [15]. These diagrams can be described by the equivalent electric circuit shown in figure 11. Where R$_e$ represents the electrolyte resistance , R$_f$ the resistance of the corrosion layer film, CPE 1 the constant-phase element representing the corrosion layer capacity, R$_t$ the resistance of the electronic charge transfert, CPE 2 the constant-phase element representing the double layer capacity, ZD the Warburg diffusion impedance.

Figure 11: Equivalent electric circuit for zinc A.
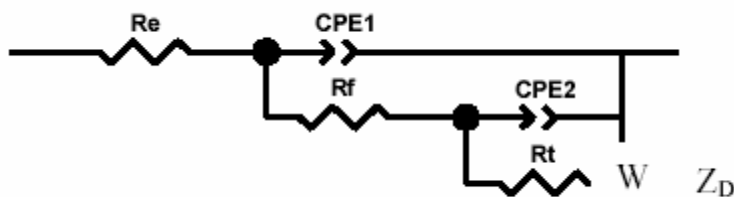
R_e - electrolyte resistance ,
R_f - resistance of the corrosion layer film, CPE 1 - constant-phase element representing the corrosion layer capcacity,
R_t - resistance of the electronic charge transfert, CPE 2 - constant-phase element representing the double layer capacity,
Zw Warburg diffusion impedance.

The resistance of the corrosion layer and electronic charge transfert are estimated at 50 Ω cm^2.
Rp decreased with immersion time. This result should be attributed to an increase in the real surface caused by intergranular corrosion.

- After 11 hours immersion a capacitive loop that is off-centre is observed again. It should be attributed to the corrosion layer and electronic charge transfer at high frequency and diffusion in the corrosion layer at low frequency. R_p did not change significantly and was evaluated at 200 Ω. cm^2 (Bode diagram) as previously.

The diffractograms in figure 5 and Table 3 show the reduction in the inter-reticular distances d(hkl) of zinc A compared with the d(hkl) values in the ASTM sheet. These results confirm the chemical heterogeneity of the material structure. Elements other than zinc were present at the grain boundaries. Intergranular corrosion was visible only after shorter immersion times.

The impedance diagram for zinc B (figure 12) shows a rapid and small change according to immersion time, then stationarity is observed.

Figure 12: Electrochemical impedance spectroscopy at different immersion times in drainage water for zinc B. - Measurements performed at corrosion potential. Nyquist and Bode diagrams.
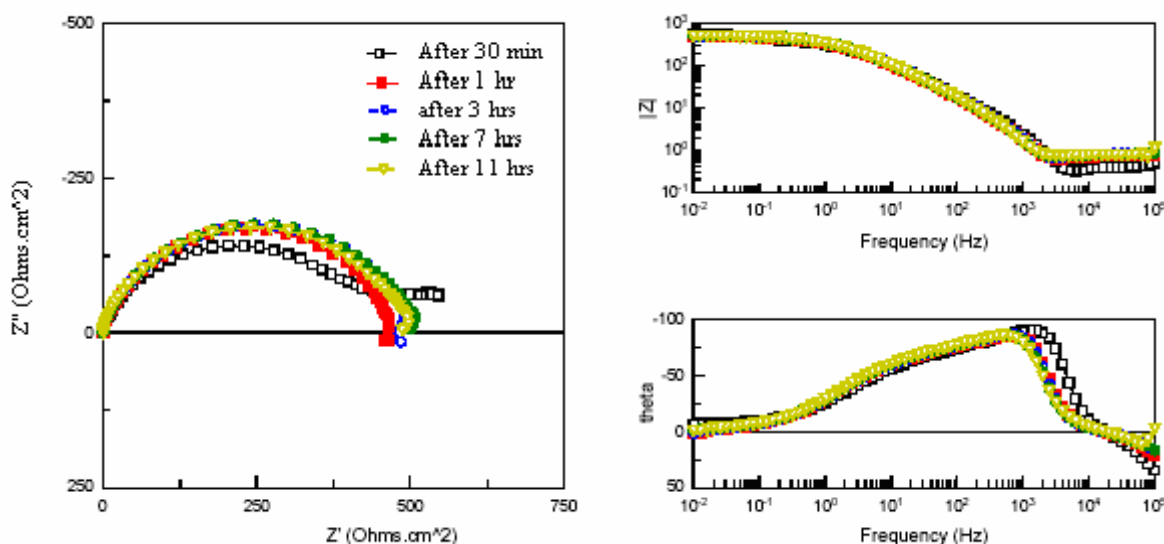

- The first diagram, after 0.5 hr, presents a slight discontinuity at low frequency on Nyquist diagram. The capacitive loop at high frequency should be attributed to the corrosion layer and electronic charge transfert as previously. This resistance was estimated at 400 Ω.cm^2. The linear

part obtained at low frequency (<0.1 Hz) should be attributed to diffusion across corrosion layer. R_p was evaluated at 550 Ω. cm^2.

- For immersion times longer than 1 hr, all of high frequency capacitive loops are identical on Nyquist diagram, indicating uniform corrosion. Rp varies from 480 - 520 Ω. cm^2. This value is higher than with zinc A. It is possible to expect zinc B more resistant to corrosion than zinc A. This is an advantage for the service life of the sacrificial anode. This effect should be explained by the homogeneous composition of the microstructure of zinc B. The diffractograms in figure 5 and Table 3 show the increase in the crystal lattice parameters. The dissolution in the grains of all the elements other than zinc during fusion and cooling resulted in a homogeneous chemical composition of the grain.

  Figure 13, the impedance diagram for zinc C is identical in shape as previously, except in the case of 0.5 hr immersion. The capacitive loop representing the 0.5 hr immersion time is off-centre compared with the real axis (on Nyquist diagram) and is followed by a linear part at low frequency (<1Hz) due to the electrolyte diffusion across corrosion layer. R_p was evaluated at 220 Ω. cm^2.

Figure 13: Electrochemical impedance spectroscopy at different immersion times in drainage water for zinc C. - Measurements performed at corrosion potential. Nyquist and Bode diagrams.
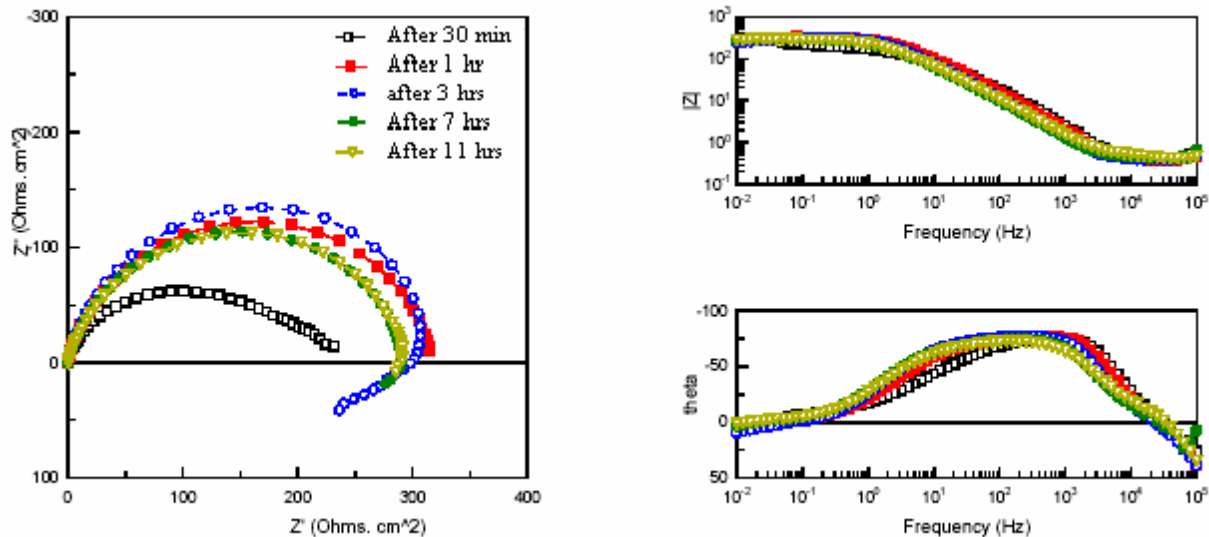

- After 1 hr immersion, all the capacitive loops are similar on Nyquist diagram. R_p increased between 280 - 320 Ω. cm^2 with immersion time. This should be attributed to the microstructural state of zinc C. Because of the lower nitrogen flow rate during cooling, dissolution of chemical elements other than zinc was reduced comparing with zinc B.

- For immersion times of 1h, 3h, 7h and 11h, there was a direct correlation between the microstructural state and the R_p values. It is possible to expect zinc C less resistant to corrosion than zinc B and more resistant than zinc A.

  The fact that zinc D was allowed to cool in the furnace contributed to its return to the microstructural state of zinc A. Figure 14, one or two capacitive loops can be observed on Nyquist diagram according to the immersion time. The corrosion layer and electronic charge transfer should be attributed to high frequency capacity loop and electrolyte diffusion through the corrosion layer at low frequency (<1Hz) capacity loop. The corrosion layer and electronic charge transfer resistances can be estimated to 60 Ω.cm^2. This value is to be compared with 50 Ω.cm^2 in the case of zinc A. The more centered capacitive loops appear only for the 7 hr and 11 hr immersion time. For times of 0.5, 1 hr and 3 hr, the capacitive loops are very off-centre. R_p increased from 75 to 200 Ω.cm^2 with immersion time. The position of the most intense lines of diffractogram of zinc D (figure 5 and Table 3) is almost

identical to that of zinc A, except that the most intense diffraction planes are not necessarily the same. There was no dissolution in the grains of other chemical elements than zinc that had precipitated at the grain boundaries during cooling. It is possible to expect zinc D as corrosion resistant as zinc A.

Figure 14: Electrochemical impedance spectroscopy at different immersion times in drainage water for zinc D. - Measurements performed at corrosion potential. Nyquist and Bode diagrams.
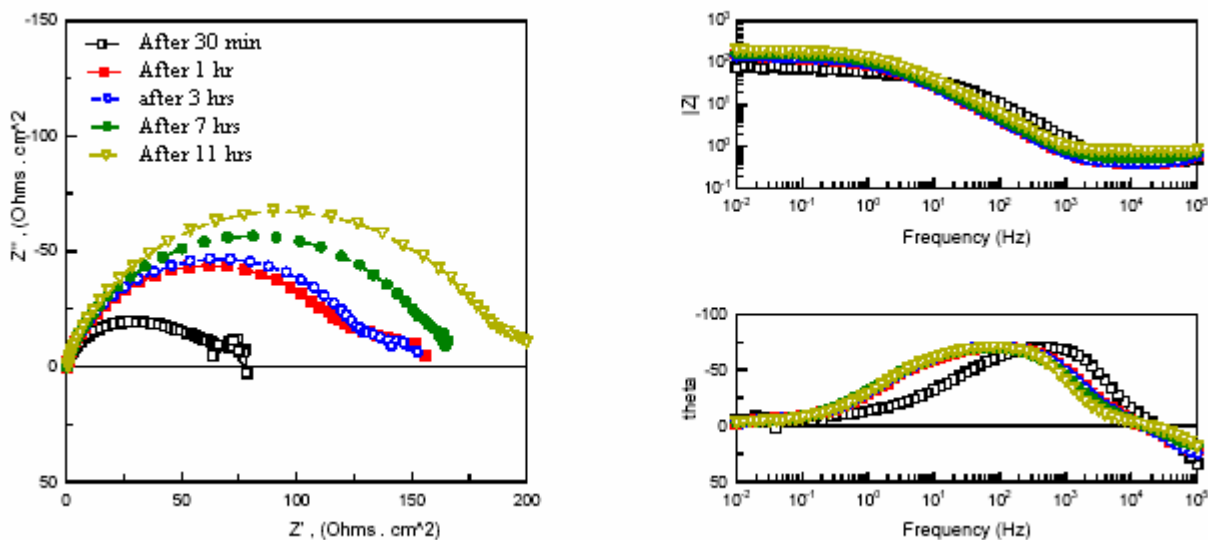
SEM observations of the specimen surfaces after 11hr immersion at corrosion potential confirmed the formation of a corrosion layer on the zinc metal.

Conclusion

Algerian zinc alloy (A) used for sacrificial anode is studied as reference and three microstructural states obtained by fusion treatment followed with three different cooling conditions (B,C,D) are examined. The most fine grains are obtained with zinc B, in another case the grains are irregular in size and less homogeneous in composition.

Corrosion potential, linear potential scan voltamperometry and potentiostatic measurements are not function of the microstructural states of the zinc alloy.

The EIS diagrams of the materials evolved as a function of microstructural state and immersion time. Evolution of EIS diagrams for zinc A as a function of immersion time can be attributed to electrolyte diffusion in the corrosion layer and intergranular corrosion.

The treatment undergone by zinc C increased the corrosion resistance, while a return to the initial microstructural state of zinc A with zinc D resulted.

For zinc B, the results are consistent with uniform corrosion and in agreement with the chemical homogeneity of the entire microstructural state. The results of the study suggest that zinc B should be the best microstructural choice for use as a sacrificial anode to protect the internal carbon steel storage tank bottoms from corrosion.

Acknowledgement

References

[1]   G. M Shankel, "NACE positions for expanding role in public policy" Materials Performance; Houston; **38** (1999) 87.

[2]   C M Abreau; M. Izquierdo; P. Merino; X. R. Novoa; C. Perez, "A new approach to the determination of the cathodic protection period in zinc-rich paints", Corrosion, Houston; **55** (1999) 1173.

[3]   NACE International, "External cathodic protection of on-grade metallic storage tank bottoms," NACE Standard Recommended Practice RP019393. NACE, Houston (Oct. 1993).

[4]   S. C. Dexter; J. P. La Fontaine, "Effect of natural marine biofilms on galvanic corrosion", Corrosion; Houston; **54** (1998) 851

[5]   R. L Benedict; J. G Ott II; D. H Marshall; D. White, "Cathodic protection of prestressed concrete cylinder pipe utilizing zinc anodes", Materials Performance; Houston; **36** (1997) 12

[6]   J. A. Schramuk ; K. Switzer ; "Making sure cathodic protection works", Water Engineering & Management; Des Plaines; **141** (1994)16.

[7]   M. Ali; A. A. Al Beed; "Tank bottom corrosion caused by inappropriate construction practices", Materials Performance; Houston; **37** (1998) 20.

[8]   P.E Myers ; G. M. Mulvany ; N.Ntela,; "Analysis of tank failure reveals oversight in inspection procedures", Oil & Gas Journal; Tulsa; **95** (1997) 47.

[9]   9 . X.G. Zhang, "Corrosion and Electrochemistry of zinc" Ed Plenum Press , (New York and London 1996) pp 183-238, 407

[10]   T. H Lewis Jr; "Take a deeper look at cathodic protection", Chemical Engineering Progress; New York; **95** (1999) 55.

[11]   NACE International, "External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms," NACE Standard Recommended Practice RP019393. NACE, Houston (Oct. 1993).

[12]   S.E. Faidi, J.D. Scantlebury, P. Bullivant, N.T. Whittle, R. Savin, "An Electrochemical Study of Zinc-Containing Epoxy Coatings on Mild Steel." Corros. Sci. , **35** (1993)1319.

[13]   M. Bounoughaz E. Salhi, K. Benzine, E. Ghali, F. Dalard , « A comparative study of the electrochemical behaviour of Algerian zinc and a zinc from a commercial sacrificial anode », J. Mater. Sci. **38** (2003)1139.

[14]   D LANDOLT « Corrosion et chimie des surfaces des métaux » Ed Presses Polytechniques et Universitaires Romandes, (Lausane, CH, 1997) pp203-205

[15]   J P DIARD, B LE GORREC, C MONTELLA « Cinétique électrochimique » Ed HERMANN, Editeurs des Sciences et des Arts, Collection Méthodes, (Paris, Fr, 1996), pp250-258

Queuing Theory in the Definition of Information Systems Development Priority

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Abstract

Each information system requires a "different" time for its development and that they are separated in systems requiring a lot of development (large projects) and in systems which are less time-consuming (small projects). The paper offers a theoretical framework that defines priorities for information systems development. It determines a rule for the priority definition and suggests a mathematical model it optimizes the systems' development priority and (as a result of this optimization) as well, improves the operations of the Enterprises' department.

Introduction

The most important success factor of the works of the Information Systems (IS's) Department is the definition of the order of priority of the systems development, by the Analysts and Programmers teams.

Unfortunately, the priority when put in action, is usually defined on the basis of the time of the user departments applications, and it is accommodated first. Usually, the most dynamic department or the department whose director is the most dynamic is accommodated first without examining if this is for the advantage of the enterprise.

On defining priority, two ideas must be taken into account:
- the utility of the system to be developed, and
- the operational needs of the enterprise.

The problem is believed that can be solved, even partly, by these ideas that should be combined with the following suggestions concerning the adoption and development of the queuing theory. To

begin with, a positive effect is a reduction in the waiting-time of user departments requesting the development of systems.

It is well known that each information system requires a "different" time for its development and that they are separated in systems requiring a lot of development (large projects) and in systems which are less time-consuming (small projects).

In the case where systems are considered as "customers" and the project teams (Analysts-Programmers) are "service points", then the relation :

$$x = \frac{average \_ time \_ of \_ small \_ systems \_ developmen \ t}{average \_ time \_ of \_ l \arg e \_ systems \_ developmen \ t}$$

gives the average service (development) time of systems which ranges between 0 and 1.

Supposedly customers can be separated in two groups, named fast and slow customers and q is the ratio of their servicing times: q= (average servicing time of fast customers/ average servicing time of slow customers).

If it is supposed that the number of "small" (less time-consuming) systems as well as the number of "large" (time-consuming) systems is known. The symbol ◊ is given in the fraction of the number of small systems in relation to the number of all systems:

$$◊ = \frac{number \ of \ small \cdot systems}{number \ of \ all \ systems}$$

◊ shows the percentage % of systems which belong in the category of "small" systems.

Priority Determination

Subsequently, a rule determining priority is established. According to this rule, as soon as a system is developed, the development of the first (requested) small system begins and if there is not a small one, then the development of the first (requested) large system begins. In fact, if a high priority is deliberately given to the small systems which need short service time, the mean size of the queues and the queuing times can be reduced.

It is obvious that the established rule reduces the average waiting time ; if supposedly there are only two systems- the small (A) which requires 100 man-hours in order to be developed, and the large one (B) which requires 1000 man-hours-, and given that, in the IS's Department there is only one team of Analysts –Programmers, then, no matter which systems is developed first (either A or B), the co-efficient of use (σ) is the same, since the total time that the team must work is 1000+100=1100 man-hours. Consequently, if B is developed first, then A will wait 1000 man-hours in order to be developed. If A is developed first, then B will have to wait only 100 man hours. In the second case, the benefit in the waiting time is 1000-100= 900 man-hours.

In practice, the reduction percentage of the average waiting-time, based on the formerly established rule, depends on the three already mentioned coefficients:

x =   time (percentage relation) that small systems need for their development in relation to large ones,

μ=   percentage of small systems in relation to the number of all systems,

σ =   use coefficient, and

is given by the following formula:

$$\Pi = \frac{100\mu(1-\mu)(1-\chi)\sigma}{1-\mu+\mu\chi(1-\sigma)}$$

which gives the percentage % of the reduction of the average waiting time?

Numerous authors suggest various methods which are, also, based on the estimation of the waiting-time cost. Particularly known is the "rule" by Cox and Smith or "c/t rule" according to which, the systems to be developed, are separated in groups each one of which has the same "co-efficient" of cost and subsequently the minimization of the entire cost of the average waiting time is affected.

The rule states that if c_i is the cost coefficient for the i_{th} system to be developed, and, t_i is the time that is expected to be developed, then, the system with the higher (c i/t i) has the highest priority.

Mathematical Model

Following, a mathematical optimization model is suggested to optimize the problem for the definition of the systems development priority. This model is based on the queuing theory and uses a system of burden values according to which each system to be developed "is charged" in proportion to the wished priority, namely, with a larger amount for priorities with low waiting time, and smaller amount for priorities with "high" average waiting time.

By the definition of various burden amounts of the systems and the relevant information of user departments, it is certain that their personnel (users) will carefully evaluate all factors before define the priority which is required for their system in the IS's Department.

The values used are steady and readjusted from time to time. The cost in the model, and for the time unit describing delay of the systems to be developed, is a random variable "κ" with probability (density) function $\sigma(\kappa)$, which can be varied from one IS Department to another in accordance to the nature and the importance of the requested and offered services.

It is accepted that the arrivals procedure follows the Poisson distribution in an average arrivals (applications for new systems) rate "λ", and an be organized in such a way that applications for new systems could be accepted only within defined time periods wherein the development of systems will be completed.

In addition, it is accepted that for each system, the time required in order to "settle" its "application", the time of its development and the cost per delay time unit, are independent random variables and at the same time, they do not depend on the selected values for all other systems that will be developed.

If "i_{th}" is defined as the average servicing time (on the arrival of the application), and accept that the IS's Department has ν "special" queues (teams of Analysts-Programmers), the i_{th} queue (i=1,2,… ν) will have priority over the j th queue if i<j.

At the beginning of the development of a system by the i_{th} queue, the user department "pay" x_I monetary units, and it will be $x_I > x_j$, if i < j.

The queues are not "saturated" since the traffic intensity ρ is smaller than one (p<1), as in the IS's Department each project team is occupied with the development of only one system which is usually complete before the need is "born" for the development of an additional new system.

In the case where each one of the systems to be developed will be dealt by any queue which would be "free" during the time the system's application arrived, and, if $\nu_I = 0$ of queues (teams) number, then, the traffic intensity [mean rate of arrival (λ) / mean rate of service(μ), $\rho=\lambda\backslash\mu$] will be:

$$\rho = \frac{\lambda}{\nu\mu}$$

and since necessarily p<1 or $\lambda/\nu\mu$<1, the mean arrival rate will be $\lambda<\nu\mu$ and the waiting probability for service will equal to ρ.

In addition, if the probability that there will be no systems to be developed is P, then:

- the Mean Number of systems in the queue will be:

$$N1 = \frac{\rho(\rho\nu)^\nu}{\nu!(1-\rho)^2} P$$

- the Mean Number of systems in all queues will be:

$$N_\sigma = \frac{\rho(\rho\nu)^\nu}{\nu!(1-\rho)^2} P + \rho\nu$$

- the Mean Time of a system in the queue will be:

$$X_1 = \frac{(\rho v)^v}{v!(1-\rho)^2 v\mu} P$$

- The Mean Time of one system in the "system" of queues, namely, the mean time of development of a system will be:

$$X_\sigma = \frac{(\rho v)^v}{v!(1-\rho)^2 v\mu} P + \frac{1}{\mu}$$

In the suggested system however, as it has been stated, the priority "increases" when the cost of the waiting time unit increases. Thus, for the delay time unit (τ_1) there will be a value, which could belong in a system, which, for example, for two queues (1 and 2) will guarantee the arrangement under queue 1 of all incoming application for new systems with $\kappa>$and, under queue 2 those if the queue 1 has higher priority over queue 2.

In figure 1 there are v queues of priority levels so that:

$T = \{\tau_I : \tau_1 > \tau_2 > \tau_3 > \ldots \tau_{v-1}\}$

It is herein stressed that τ_1 is the point separating queue (ι) and queue ($\iota+1$).

The system of values, (given that priority (i) is higher than priority (i+1)), will "motivate" for the assigning to the queue with priority (ι) of the applications for the new systems with $\tau_i < \kappa < \tau_i$-1 are assigned in the queue with priority (i), and for the new systems with $\tau_I \leq c \leq \tau_{i-1}$ and in the queue with priority (i+1) those with $\tau_{I+1} \leq c \leq \tau_{i-1.}$

Subsequently, the optimization of τ_I is attempted, where (i=1,2,3,…, v-1) and is defined as the "right of use" (of the IS's Department) a queue of monetary units m = { $m_i=m_1>m_2>m_3>\ldots m_n$), in which m_1 is the priority "right" (i), and, $m_i>m_{s,}$ if i<j.

The queue of monetary units should be such so as to motivate the user departments in order to minimize their total average waiting cost.

Having this in mind, and since τ_I is the "optimum" separating point between queues (i) and (i+1), the optimum ratio of systems to be developed which should be dealt by the various queues, is known. Likewise, it is necessary that every new application concerning the development of a system arriving with c=τ_I should have the function of the total average cost equal to the function corresponding to queue (i+1). Namely, the user department should not have any problem to choose between queue (i) and (i+1).

Consequently, if:

m_i= monetary unit of the "right of use" of the priority (i), and

m_{i+1} = monetary unit of the "right of use" of priority (i+1),

Then

$m_i+\tau_i T(A_i)=m_{i+1}+\tau_i T(A_i+1)$ (a)

for i=1,2,3,... v-1

and wherein $T(A_i)$ and $T(A_{i+1})$ are correspondingly the expected waiting times in priorities (i) and (i+1).

Additionally, since the optimum values of τ_i for i=1,2,3,…, v-1 are calculated, then, $T(A_i)$ and $T(A_{i+1})$ can be calculated. On the basis of equation (a) the following (equation) is reached:

$(m_i - m_{i+1}) = \tau_i [T(A_i+1) - T(A_i)]$

where, for i=1,2,3,…, v-1, it defines the optimum values of monetary units concerning the "right of use".

"Amounts" are calculated and announced in the user departments along with the corresponding predicted waiting times in each priority.

Needless to say that for higher priority, more ¨money¨ are ¨paid ¨ which are either given by the direction of the IS's Department to the administration of the company, or, if the administration of the company allows these amount to be used for improvements, expansions of the EDP equipment and for the staff's training and education.

Further, and since priority (i) is higher than (j), the following relation will be valid:

$T(A_i) < T(A_j)$

Where $T(A_i)$ and $T(A_j)$ are the expected waiting times in priorities (i) and (j).

Optimization - Conclusions

Given that every user department will base its decision on the purpose to optimize its operations, the suggested "values system" will lead to an optimization of the operations of all those services since, it aims at defining the optimum distribution of priorities.

This optimization is achieved when the total (expected) delay cost T is minimized in relation to the cost of points of the "separation" τ_I (Figure 1). This minimization process will result in finding the τ_I values, as well as the ratio of the systems that will be developed by each queue (team) and the mean waiting time in each queue as well.

Figure 1:
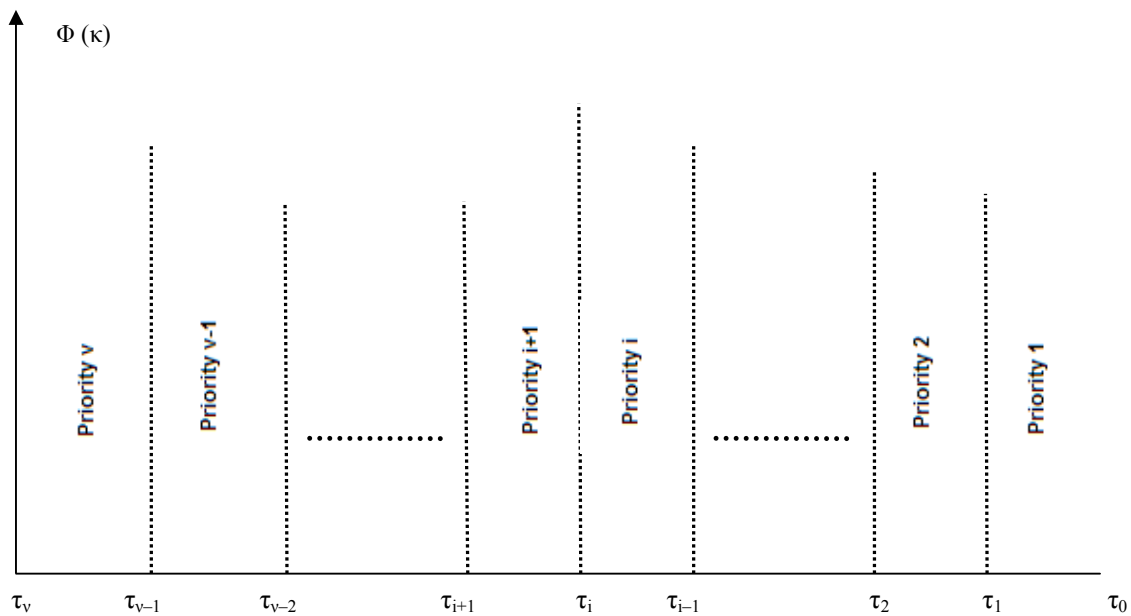
References

[1]   Ackoff R., M. Sasieni, "Fundamentals of Operations Research", John Wiley & Sons, Inc

[2]   Air France, "EDP Management Manual"

[3]   Alter S, "Information Systems: A Management Perspective", The Benjamin/Cummings Publishing Co., Inc

[4]   American Airlines, Inc., "Electronic Data Processing Administration Manual"

[5]   American Airlines, Inc., "Operational Research Manual"

[6]   Auerbach Information Management Series, "Data Processing Management", DP Administration

[7]   Ashby W. Ross, "An Introduction to Cybernetics", University Paperbacks, London

[8]   Baltz H., R. Baltz, "Fundamentals of Business Analysis", Prentice-Hall, Inc. Englewood Cliffs, N.J

[9]   Bazovsky I., "Reliability Theory and Practice", Prentice-Hall

[10]   Blackman M., "The Design of Real Time Applications", John Wiley Ltd

[11]   Boar B.H., "Application Prototyping", John Wiley & Sons

[12]   Boulanger D.G., PERT…a case study application with analysis, "Decision Theory and Information Systems: An Introduction to Management Decision Making" South-Western Publishing Company, Cincinnati, Ohio

[13]   Brandon D., M. Gray, "Project Control Standards", Brandon/Systems Press, Inc

[14]   Brathwaite K.S., "Data Administration", John Wiley & Sons

[15]   British Airways, "Cost/Effectiveness of Computer Projects Manual"

[16]   British Computer Society, "Computers and the Professional", The BCS Code of Good Practice, The National Computing Centre Ltd.

[17]   Burch J., F. Strater, "Information Systems: Theory and Practice", John Wiley & Sons, Inc., (Hamilton Publishing Co)

[18]   Burriel C., L. Ellsworth, "Modern Project Management", Burrill-Ellsworth Associate Inc., Tenafly, N.J

[19]   Canadian Pacific Air, "Cost Effectiveness of Computer Projects Manual"

[20]   Carr C.R., C. W. Howe, "Quantitative Decision Procedures in Management and Economics", McGraw-Hill Book Company

[21]   Carter R., "The Information Technology Handbook", Heinemann Professional Publishing Ltd

[22]   Chandor A., J. Graham, R. Willamson, "Practical Systems Analysis", Rupert Hart-Davis Educational Publications, London

[23]   CDC (Control Data Corporation), "Computer Systems Applications Guide"

[24]   CDC, Control Data Institute, "Project Management Manual", Amsterdam

[25]   Couger J.D., R.A. Zawacki, "Motivating and Managing Computer Personnel", John Wiley & Sons