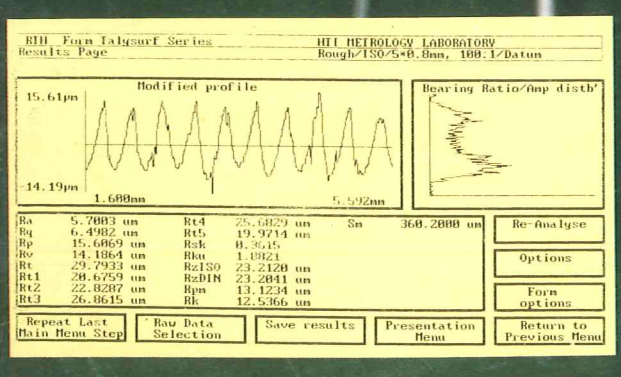
Review

THE HIGHER TECHNICAL INSTITUTE



Number 25 September 1996 Nicosia Cyprus

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DeLeMa

The Higher Technical Institute (HTI) was established in 1968 as a Government of Cyprus project with assistance by the United Nations Special Fund (UNDP), the United Nations - Educational-Scientific and Cultural Organisation (UNESCO), the International Labour Office (ILO). Cyprus Government Executing Agency: The Ministry of Labour and Social Insurance.

HTI Review

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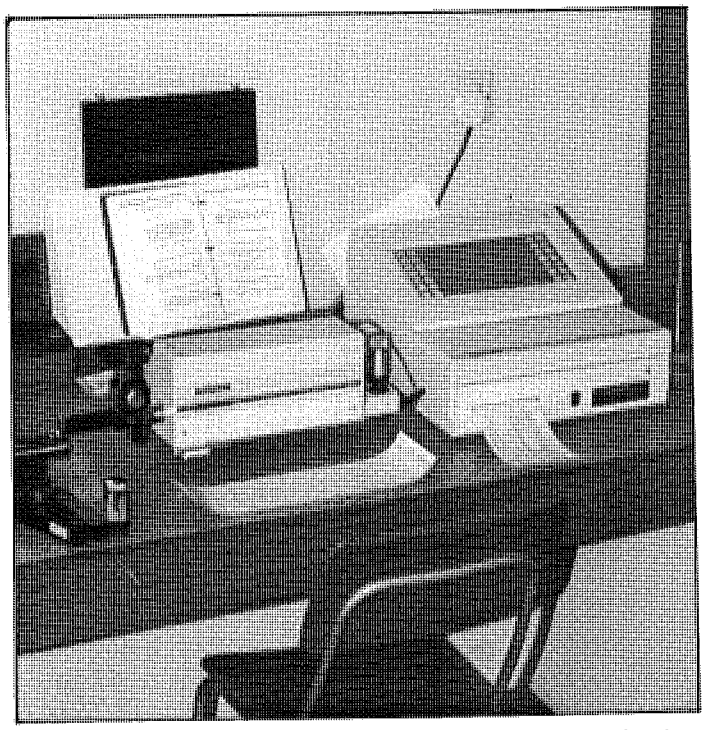

The HTI Talysurf Surface Finish Measurement Unit used for the Taguchi Design of Experiments (DOE). Please refer to pages 70-76. *Photo by Ioannis Angeli.*

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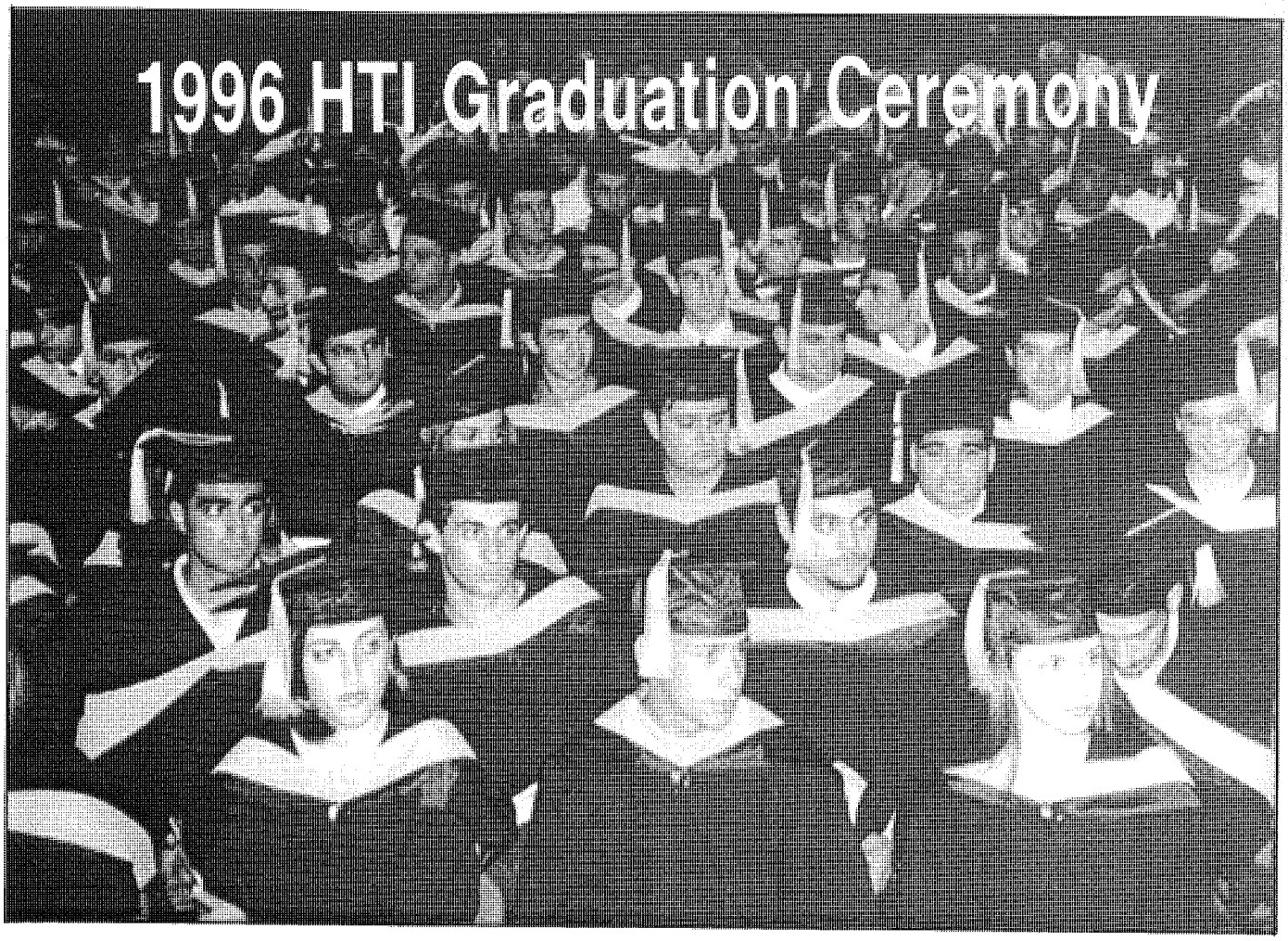
CONTENTS

1996 HTI Graduation Ceremony



The Higher Technical Institute held its 26th Graduation Ceremony for the academic year 1995-96 on Monday, 1 July, at the Cyprus International Conference Centre in Nicosia.

The President of the Republic, Mr Glafcos Clerides, attended the Ceremony and awarded the Presidential Prize of í2.000 to Mr Elias Kyriakides, the graduate with the highest overall performance. Additionally, the President donated í2.000 from his personal budget in aid of the needy students of the Institute.

The Minister of Labour and Social Insurance, Mr Andreas Moushouttas, awarded the diplomas to the one hundred and fifty-eight graduates.

The Director of HTI, Mr Demetrios Lazarides, awarded the prizes sponsored by industry and professional bodies to the graduates who excelled in their studies.

The Ceremony was attended by the Director General of the Ministry of Labour and Social Insurance, Mr Nicos Symeonides, members of Parliament, members of the diplomatic corps, government officials, representatives of the political parties, trade unions and professional bodies.

The President of the Students Union, Mr Ioannis Papadopoulos, addressed the gathering highligting the successful work of the Institute while stressing at the same time the need for re-structuring and upgrading of HTI in order to meet future challenges. He also reinstated the determination of the student community to fight for the freedom of the occupied part of their homeland.

The main speaker was the HTI Director who thanked the President of the Republic and other dignitaries for honouring the Ceremony with their presence.

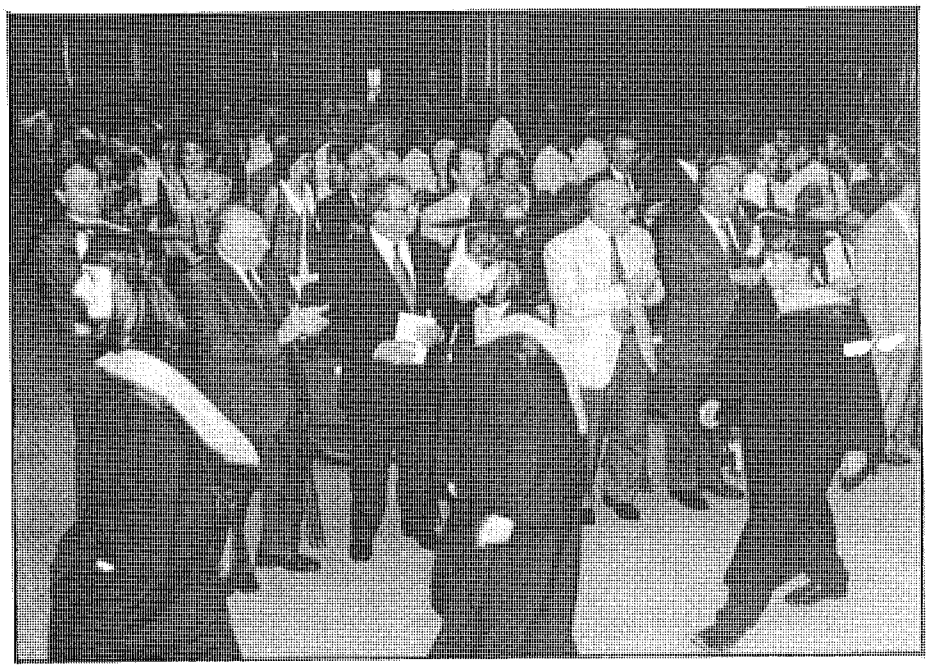
Firstly, Mr Lazarides outlined the academic achievements and future targets of HTI. He highlighted the fact that HTI in addition to the one hundred and fifty-eight graduates of the regular three-year programmes, has organised in co-operation with the Industrial Authority of Cyprus 27 short professional courses which were attended by 493 professionals. Thus, HTI can be regarded as the mainstay of the Cyprus Industry.

On the other hand, HTI graduates with their high technical expertise, who join the ranks of the National Guard annually, contribute greatly in the efforts of the Government to upgrade our Defence Programme.

Regarding the legal status of the operation of HTI Mr Lazarides said that considerable progress has been made towards this issue for

a draft proposal was sent to the office of the Attorney General while a law bill is expected to be forwarded shortly to the House of Representatives.

As far as the professional status of HTI graduates is concerned, Mr Lazarides announced, that it had been agreed in principle that a special post that of "Technician Engineer" should be created within the Civil Service Sector. This development is regarded as of great benefit to HTI graduates for their professional status will be in turn recognised by the semi-government and private sectors. Moreover, ETEK is proceeding towards professional recognition of all HTI graduates in their particular specialisations.



Graduating Students in uniform entering the hall for the Graduation Ceremony

However, an educational establishment like HTI, Mr Lazarides added, should enjoy those facilities which will enhance its work and make it more effective. For this purpose the Government ensures that HTI keeps up with modern developments by upgrading the equipment of its laboratories and it is planning to build a new multipurpose Palais de Sports. This year alone about half a million pounds will be spent on replacing obsolete equipment, purchasing new technology, hardware and software.

The Minister of Labour and Social Insurance, Mr Andreas Moushouttas, awarding the diplomas to the Graduating Students

Additionally, Mr Lazarides continued, there is a noticeable increase in the budget for staft development and the purchase of specialised literature and journals which will help HTI to meet the challenges it will face with the introduction of the new educational system which is under consideration by the Academic Council of the Institute.

HTI staff, the Director said, have been involved in various research projects. Five of these research projects are being financed through EU budgets. Moreover, HTI staff became involved with local research projects and offered consultancy services to the Cyprus industry and other organisations.

In fact, Mr Lazarides went on to add, the achievement of the Institute so far creates a feeling of optimism and favourable prospects for HTI and its future. Its 3453 graduates have contributed decisively in the development and upgrading of the industry and technical services of the island. Indeed, it would be no exaggeration if we called HTI the main "blood donor" of the Cyprus industry.

Mr Lazarides dwelt in particular on the untimely deaths of two members of HTI staff: the late Marios Pattichis and Pantelis Vasiliou who passed away at the age of 45 and 55 respectively. They both served both as lecturers and senior lecturers at HTI. Both staff and students mourned and commemorated their deaths with various activities.

Concluding, Mr Lazarides addressed thanks to the various industries, organisations and indviduals who supported HTI work by offering donations, prizes and scholarships.

He went on to wish the graduates, on behalf of the Minister of Labour and Social Insurance and the Government, success in their professional career and happiness in their private life.

He ended by assuring the President of the Republic that HTI will be in the vanguard of progress and would do its utmost to succeed in its targets. ■

A GENERIC SINGLE-NEURON MODEL

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Christos N. Schizas, B.Sc., M.Sc., Ph.D., Professor, Department of Computer Science, University of Cyprus.

1. INTRODUCTION

Since the early seminal work of McCulloch and Pitts (1947), many single-neuron models have been proposed. Some of these models are general enough to encompass most of the existing models (Amari 1977, Kohonen 1977 and 1983, Feldman and Ballard 1982, Rumelhart *et al.* 1986, Tsoi and Back 1994). In this article an alternative generalized model is proposed that it is believed to be generic enough, so that it is "parent" of most of the existing models, and detailed enough so that it is able to display all the important properties of the various models. In order to achieve a common basis for comparisons and to keep the signal representations simple, a consistently systematic notation, largely based on the control system representation formalism is used as shown in the appendix. Some well known single-neuron models are identified and represented in the form of flow diagrams compatible with the proposed model. The state equations are also shown*. The mathemeatical (algebraic and differential equations) representation allows a flexible and concise manipulation of the model, while the graphical representation facilitates the easy understanding of the relationship between structure and dynamics. Emphasis is given on the fundamental structure of the models rather than on details such as particular values and signs of constituent parameters. It is, however, pointed that the actual values of the various parameters as well as their signs, could be very important to the overall functioning of a unit and certainly to a system of interconnected neurons. Indeed, it is well known that in certain complex nonlinear models, even small variations of the controllable parameters, or of initial conditions, may lead to regions where chaotic behaviour of a single-neuron could be observed [(Aihara, 1995), (Wang and Blum, 1995)]. At the system level, the behaviour of the network may be substantially different, even when changing the proportion of excitatory to inhibitory components (Lopes da Silva and Pijn, 1995).

2. THE PROPOSED GENERIC SINGLE-NEURON MODEL

The general structure of the proposed model is shown in the block diagram form in Fig.1. The main function of this model is to help a researcher who is interested in exploring the computational properties of artificial neural systems and in organizing the field. It is not an attempt to model real biological neurons. This scheme may be viewed as a parent model of most of the existing single-neuron models, as it will be demonstrated in the following sections. The component blocks may be of considerable complexity, possibly involving local or remote feedbacks and feedforwards (whithin the neuron). These component blocks may define a subsystem in terms of functionals, dynamical operators (differentiators or integrators), or may be defined as a combination of functionals, dynamical operators, and algorithmic procedures as explained in more detail in subsequent sections.

The structural components of the proposed model shown in Fig.1 are identified to be:

1) The pre-main-accumulator processing subsystem
2) The main-accumulator processing subsystem

* The equations are presented in continuous time form. Those equations that were presented in discrete time form in the original papers, have been transformed into continuous time by using only the first order terms of a Taylor series expansion.

3) The post-main-accumulator processing subsystem
4) The output distribution subsystem (distributor)
5) The feedback(s) and feedforward(s) subsystem
6) The parameters adaptation subsystem.

This structural decomposition helps in organizing the field of single-neuron models, by suggesting the basic structure that may be used as a framework for describing and classifying model propositions. The first five subsystems, which are internal to the neuron, are further expanded in a form that fits most of the existing propositions, as described herebelow.

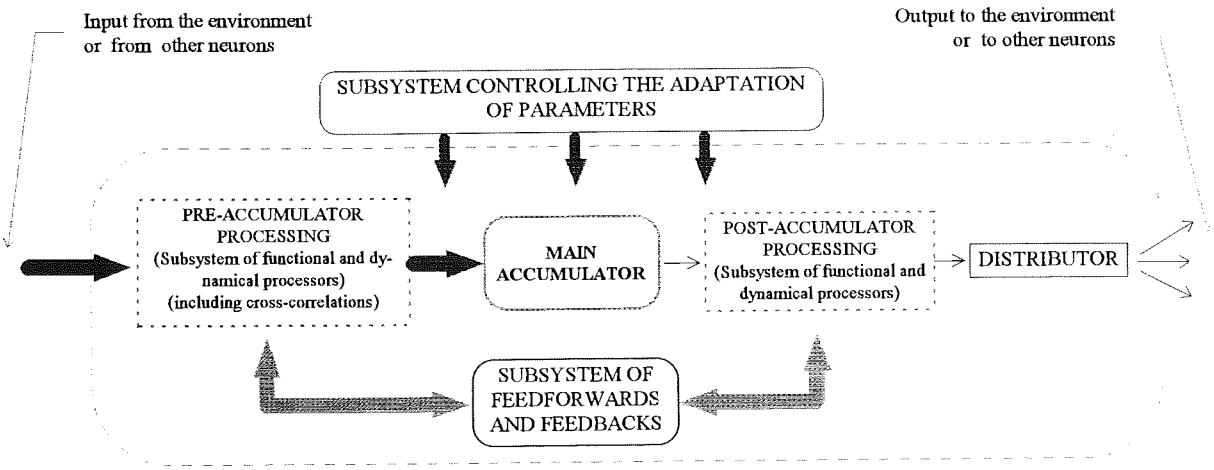


Fig.1. The general form of the single-neuron model.

2.2 Expanded form of the generic model

The components of the model of Fig.1 are further analysed as shown in Fig.2. Each of these subsystems is explained in the following sections.

2.2.1 The pre-main-accumulator processing subsystem

This subsystem is shown in detail in Fig.2(a). In the vast majority of the existing single-neuron models this subsystem is composed of a set of quasi-static adaptable weights. The possibility of using a functional relationship (instead of weights) has been proposed by Kohonen (1983) as shown in Fig.15. The structure could be further expanded as a set of two distinct subprocesses composed of dynamical transfer operators $D_{ij}^{I}(\cdot)$ and functional operators $F_{ij}^{I}(\cdot)$. By dynamical transfer operators, it is meant that the functional relationships involve time derivators and integrators. By functional operators, it is meant that the relationships are such that the input is transformed through some function or algorithmic procedure. This could be thought off as some kind of preprocessing. Currently, this is mostly done externally to the single-neurons. Suitable transformations such as Fourier or other transforms could fall within this group. Functions involving time delays have recently been explored as well. These are more complex cases where both dynamical and functional tasks could be in operation. Such a case is the model of Back and Tsoi (1990), which is exhibited in a simplified form in Fig.6.

2.2.2 The main-accumulator processing subsystem

The main accumulator, Fig.2(b), is the most essential part of the model. It operates in a manner resembling a pool or a digester, in which multiple inputs are processed in a cumulative manner, the result being transmitted as a single output. Typical examples are simple summators, multipliers and combinations of these. It is proposed that this unit could also

operate as some higher level accumulation process such as multidimensional integration in which not only the quantity of the incoming signals is accumulated, but also, possibly, some measure of quality as well. This amplifies the prospect that the accumulator may be averaging some properties (of the input signals) other than quantities, such as the colour or the sound or some chemical parameter etc. Furthermore, this unit may be a system whose operation is based on some suitable algorithm, possibly involving fuzzy logic, confined within the domain of subsymbolic operations.

Consider the following two rules as examples that illustrate this issue.

i) If some φ(x) meets a certain desired criterion (internally or externally specified), then accumulate as per desired method.

ii) If the colour of output unit meets a certain desired criterion (internally or externally specified), then accumulate as desired.

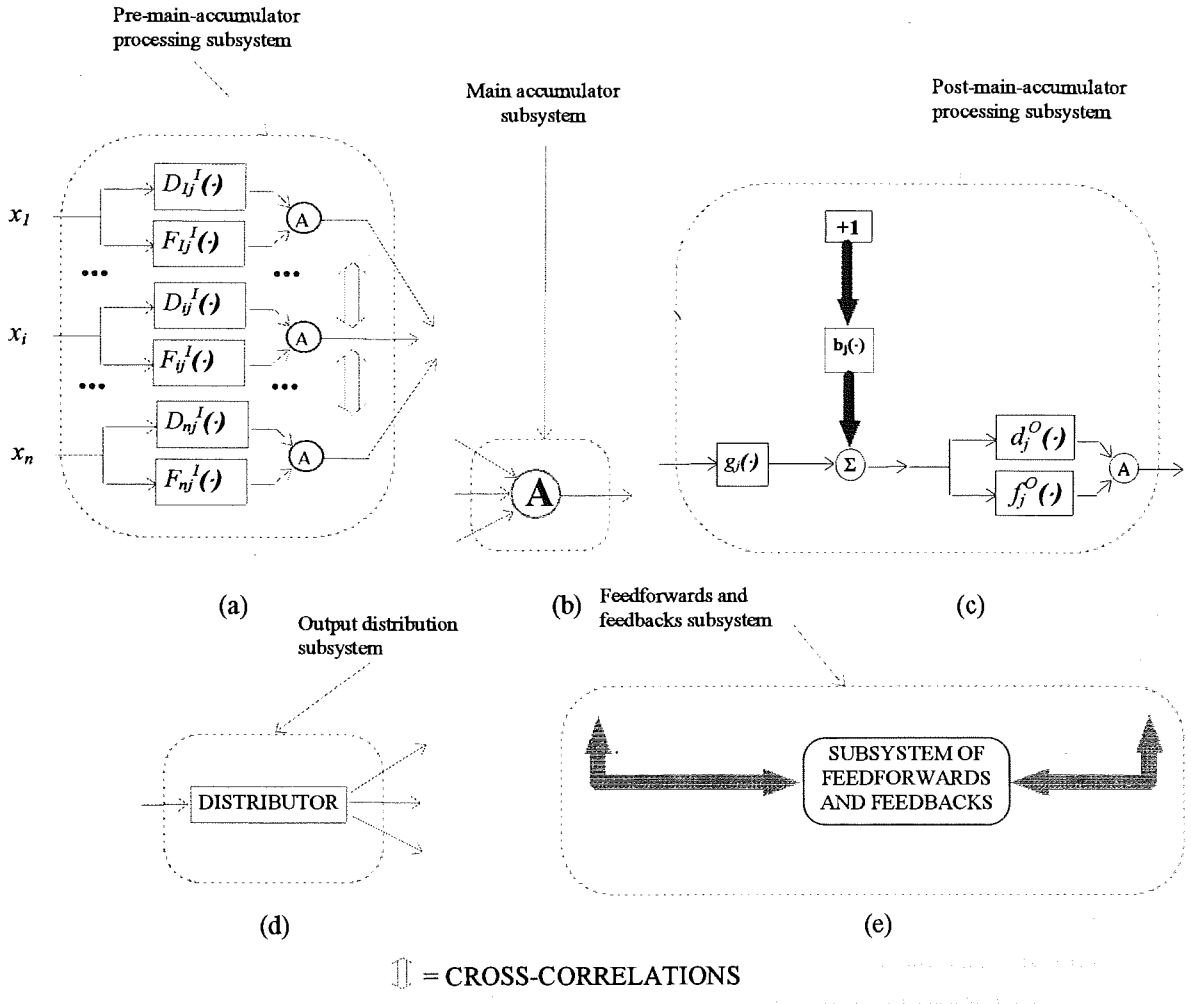


Fig.2. The components of the generic single-neuron model.

2.2.3 The post-main-accumulator processing subsystem

Many different architectures have been proposed in the past. We believe that the scheme shown in Fig.2(c) is general enough to be able to fit most of these propositions. In this Figure, $\mathbf{b}_j$ is a set of biases which are considered to be a set of controllable parameters or external inputs. Fundamentally, these are not an essential part of the model, but are included here in order to ensure compatibility with most of the previously proposed models. The post-main-accumulator processing is a subsystem composed of dynamical operators $d_j^O(\cdot)$ and functional operators $f_j^O(\cdot)$, typically a hard-limiter, a sigmoid or a gaussian.

These may be combined in different schemes, the most common appearing to be the Grossberg form (Fig.7). The term $g_j(\cdot)$ is a general functional, mainly introduced for accommodating the majority of past single-neuron model propositions. It should be stressed that the dynamical transfer operators $d_j^O(\cdot)$ and the functional operators $f_j^O(\cdot)$, are indicatively placed at the positions shown. This is done in order to be consistent with most of the models in the literature.

2.2.4 The output distribution subsystem (Distributor)

In real neurons the axonal output signal is directed to all the synapses of the sending neuron. At the chemical synapses neurotransmitters are released and directed from the presynaptic terminal to the postsynaptic terminal. Similarly, at electrical synapses polarized current is directed to the postsynaptic joint. The efficacy of this signal transmission is governed by both the sending and the receiving neurons. The present model accomodates this efficacy and allows for a rich controllability on the signal transmission. This function is represented by the output distribution subsystem shown in Fig.2(d). In this model, a component called distributor, acting like a fan-out unit is introduced. Its purpose is to control the distribution of possibly different signals to different receiving neurons. The introduction of this new component may help someone to explore other possibilities for new neurocomputing paradigms. At first thought, this feature may be considered to perform similar task as that of the adaptable weights, presently used in most artificial neural systems or similar task as the functional in the pre-main-accumulator processor of the present model. This is not so however, because with the proposed formality, the neuronal output is of more general scope. This generality allows for the possibility that the output is filtered, based on some algorithmically or otherwise specified condition, governed by either the sending neuron, the receiving neuron, or both. The existing models do not accommodate the possibility for a joint regulation and control of the synapse signal, since each neuron operates locally, basing its action on the local information available. The neurons, however could impose a conditional processing or some joint preprocessing governed by the knowledge of the state of one on the other(s). Such a system becomes more complex but it may open the way for new computational paradigms. The control of this distributor could even be exerted by an external agent, operating as an overall supervisor. Such a prospect of course may deviate from the subsymbolic formality and hence weaken the autonomy of the unit. It could however be controlled by some other subsystem belonging to the overall network. The important issue being that any new scheme will be accepted if it results in more efficient, novel and useful neurocomputational processing. To make this point clearer, two examples of possible schemes are presented here.

Suppose neuron j sends signals to neurons α, β, γ, δ.

Example rule 1:

Neuron α receives input from neuron j if the ratio of the activation of β to γ is greater than some suitable function of the activation of δ.

Example rule 2:

Neuron α accepts input from neuron j if the activation of β and γ is greater than the activation of δ and neuron j is excitatory.

Rules like these, (simpler or more complex) could be used in order to help explore for new neurocomputing paradigms.

2.2.5 The feedbacks and feedforwards subsystem

These are mostly confined in the post-main-accumulator region. In some propositions have been included in the pre-main-accumulator subsystem. A third possibility is the coupling of neuron output with the neuron input, like for instance in the so called coupled neurons, classified in later sections.

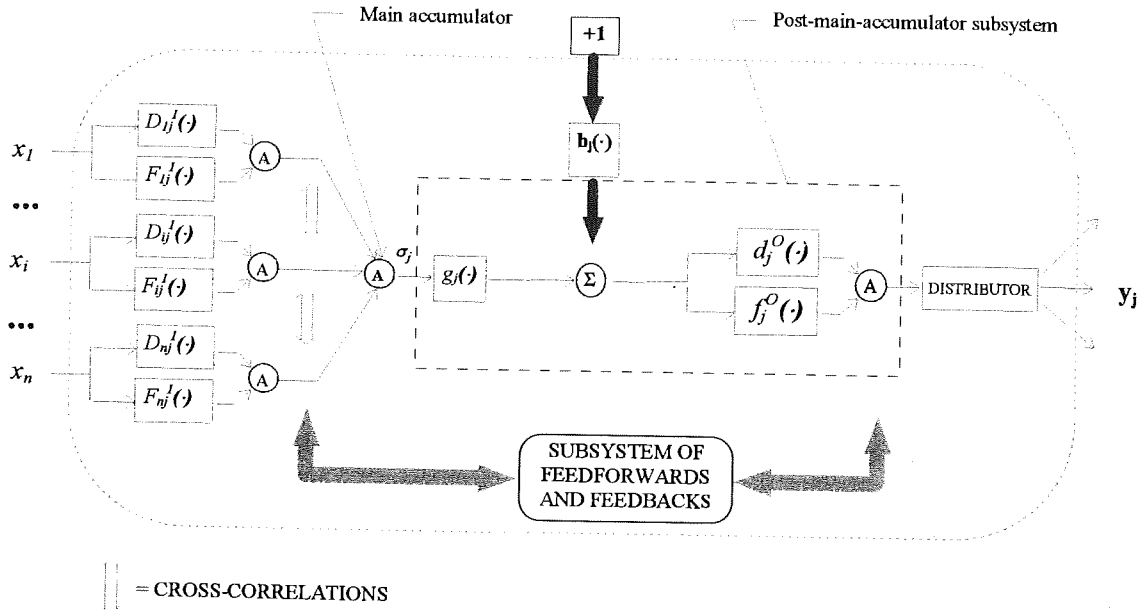


Fig.3. Detailed form of the integrated generic single-neuron model.

2.3 An integrated form of the generic single-neuron model

The previously described subsystems are put together in a detailed generic single-neuron model proposition shown in Fig.3, which indicates the flow of information from input to output of an arbitrary neuron j. By using the notation explained in the appendix involving signals in batch, this model may also be represented as shown in Fig.4.

Two important features of the model are:

i) The distinction between the two predominant pre-main-accumulator processes, namely the dynamical transfer operators $D_{ij}^I(\cdot)$ and the functional operators $F_{ij}^I(\cdot)$.

ii) The provision of the option that different outputs may be sent selectively to different receiving neurons.

The proposed form of the generic model (Figs 3 and 4), is suitable in describing most of the models suggested at different occasions by various researchers. This is demonstrated in the selected sample model representations shown in Figs. 5, 6, 7, 8 and 9†.

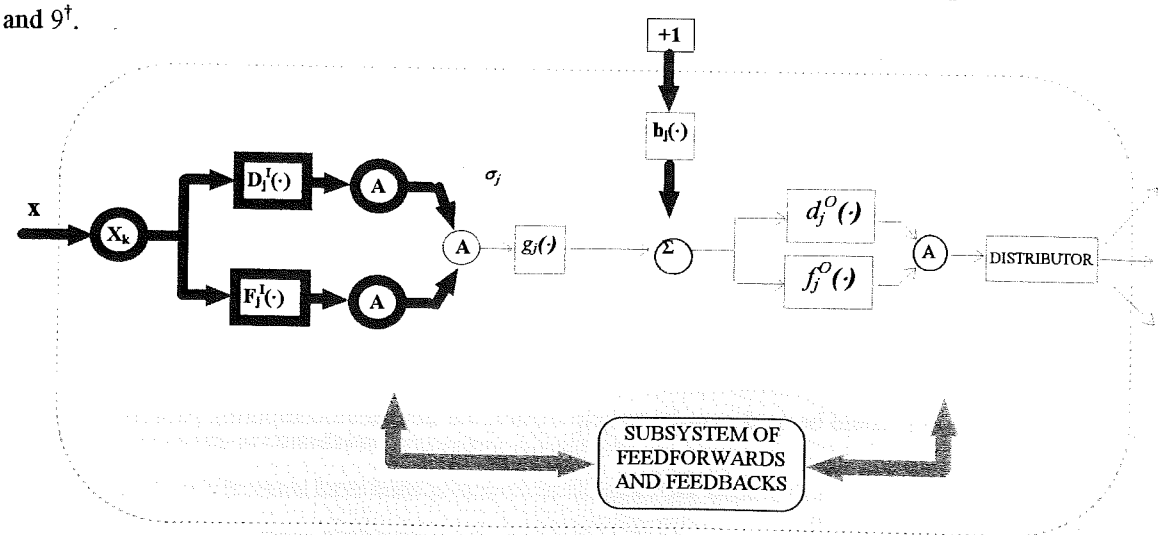
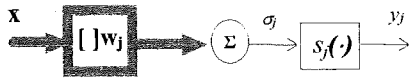


Fig.4. Vectorial form of the generic single-neuron model.

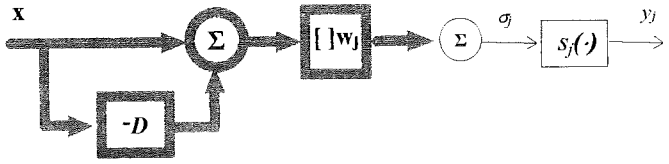
† The neuron governing activation equation(s) are shown below each block diagram. This is done so that the reader can gain a thorough understanding of both the structure and the associated dynamics.

1st example. In the specific case where there are no higher order cross-correlations, and when $D_{ij}^{I}(\cdot) \equiv 0$, $F_{ij}^{I}(\cdot) \equiv w_{ij}$, $g_j(\cdot) \equiv 1$, $\mathbf{b_j}(\cdot) \equiv 0$, $d_j^{O}(\cdot) \equiv 0$, $f_j^{O}(\cdot) \equiv$ hard-limiter, $\mathbf{y_j} \equiv y_j$, and the accumulators being summators, the model is reduced to the McCullogh and Pitts (1947) proposition shown in Fig.5.



$$y_j = s_j(\sigma_j) = s_j(\sum_{i=1}^{n} x_i w_{ij})$$

Fig.5. McCullogh and Pitts (1947)

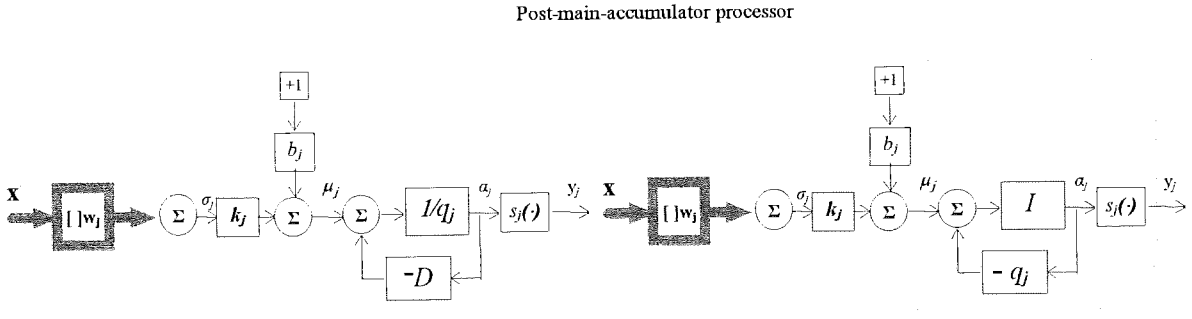


$$y_j = s_j(\sum_{i=1}^{n} (x_i - \dot{x}_i) w_{ij})$$

Fig. 6. Back and Tsoi model (1990)

2nd example. When there are no higher order cross-correlations, $D_{ij}^{I}(\cdot) \equiv -D$, $F_{ij}^{I}(\cdot) \equiv w_{ij}$, $g_j(\cdot) \equiv 1$, $\mathbf{b_j}(\cdot) \equiv 0$, $d_j^{O}(\cdot) \equiv 0$, $f_j^{O}(\cdot) \equiv s_j(\cdot)$, $\mathbf{y_j} \equiv y_j$, and the accumulators as shown in Fig.6, the model is reduced to a simplified form of the Back and Tsoi (1990) proposition (Fig.6). In this form only the first order terms of the Taylor expansion have been used. The model involves time delays in the pre-main-accumulator processor.

3rd example. When there are no higher order cross-correlations, $D_{ij}^{I}(\cdot) \equiv 0$, $F_{ij}^{I}(\cdot) \equiv w_{ij}$, $g_j(\cdot) \equiv k_j$, $\mathbf{b_j}(\cdot) \equiv b_j$, $f_j^{O}(\cdot) \equiv 0$, $\mathbf{y_j} \equiv y_j$, the accumulators being summators, and $d_j^{O}(\cdot)$ governed by dynamics as specified by the differential equation: $da_j/dt + q_j a_j = \mu_j$ and $y_j = s_j(a_j)$, the model is reduced to the Grossberg (1968) proposition shown in Fig.7.



$$\dot{a}_j = -q_j a_j + b_j + k_j \sum_{i=1}^{n} x_i w_{ij} \quad \text{and} \quad y_j = s_j(a_j)$$

Fig.7. Grossberg model (1968). (a) Derivative form (b) Integral form.

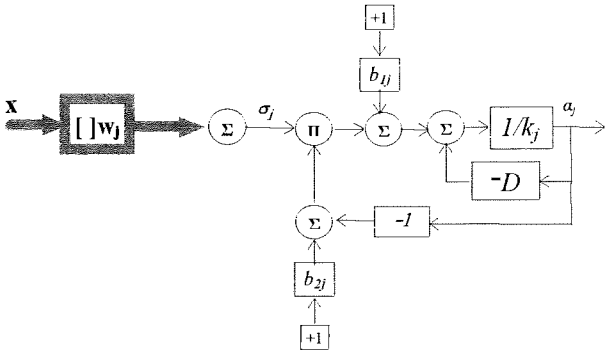
This single-neuron model, also known as the "additive short term memory" appeared in different forms in the literature [(Malsburg, 1973), (Cohen and Grossberg, 1983), (Hopfield, 1984), (Wang and Mitchel, 1994)]. The state a_j is the neuron activation, also identified as short term memory (or membrane potential) and w_{ij} the long term memory. It may be observed that in the special case when $D \equiv 0$ or $I \equiv 1$, the model is essentially reduced to the McCullogh and Pitts proposition. The activation equation of the Grossberg model is shown in eq.1.

$$\dot{a}_j = -q_j a_j + b_j + k_j \sum_{i=1}^{n} x_i w_{ij} \qquad (1)$$

This equation is also known as the *leaky integrator neuron equation* and appeared in this basic form in numerous neuronal models. It has its origins in the work of Lapicque (1907), Hill (1936), Hodgkin and Huxley (1952) and Eccles (1957) and Caianiello (1961).

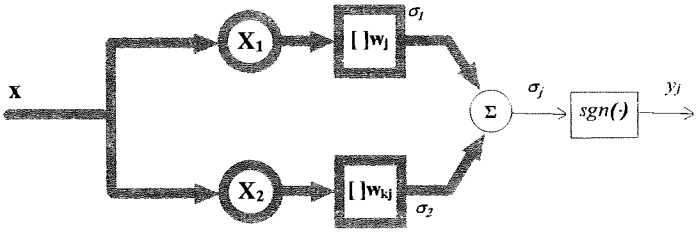
4th example. When there are no higher order cross-correlations, $D_{ij}^{I}(\cdot) \equiv 0$, $F_{ij}^{I}(\cdot) \equiv w_{ij}$, $g_j(\cdot) \equiv 1$, $\mathbf{b_j}(\cdot) \equiv b_j$, $f_j^{O}(\cdot) \equiv 0$, $\mathbf{y_j} \equiv y_j$, the accumulators being summators, and $d^{O}_{j}(\cdot)$ is governed by the dynamics specified in the equation of Fig.8, the basic structure of the McClelland and Rumelhart "Interactive Activation" model (Fig.8), is obtained.

5th example. When there are upto 2nd order cross-correlations, $D_{ij}^{I}(\cdot) \equiv 0$, $F_{ij}^{I}(\cdot) \equiv w_{ij}$, $g_j(\cdot) \equiv 1$, $\mathbf{b_j}(\cdot) \equiv 0$, $d_j^{O}(\cdot) \equiv 0$, $f_j^{O}(\cdot) \equiv sgn(\cdot)$, $\mathbf{y_j} \equiv y_j$, and the accumulators being summators, the generalized "polynomial discriminant function" proposed by Specht (1966) shown in Fig.9, is obtained.



$$\dot{a}_j = -k_j a_j + b_{1j} + (b_{2j} - a_j)\left(\sum_{i=1}^{n} x_i w_{ij}\right)$$

Fig.8. Basic structure of the model used in the "interactive activation network" (McClelland and Rumelhart, 1981)



Where:

$i = 1,\ldots,n$

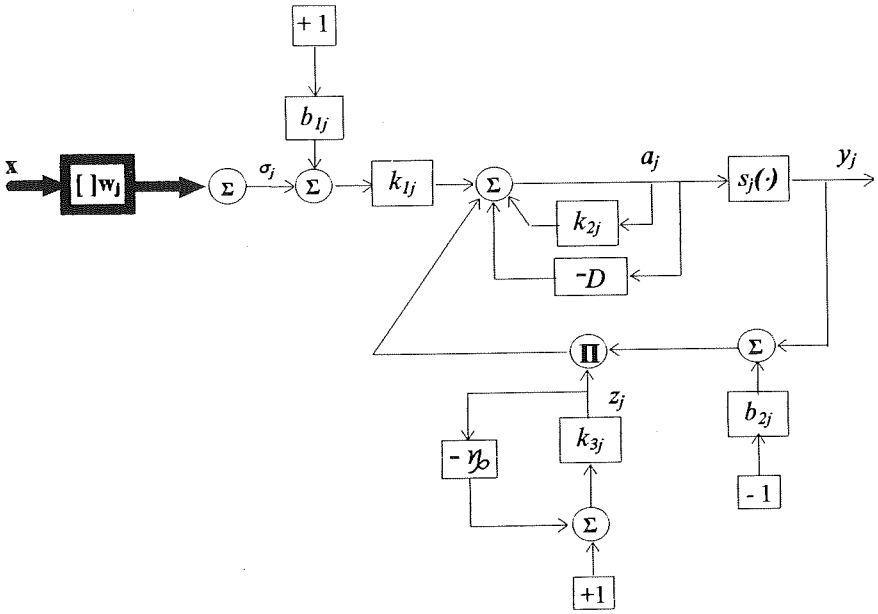
$k = 1,\ldots,n$

$$y_j = sgn\left(\sum_{i=1}^{n} x_i w_{ij} + \sum_{k=1}^{n}\sum_{i=1}^{n} x_i\, x_k\, w_{ikj}\right)$$

Fig.9. The generalized "Polynomial Discriminant Function" model by Specht (1966)

Similarly, most of the existing models can fit the proposed general scheme. For highly complex models, like the Hodgkin-Huxley (1952), the block diagram representation becomes so complicated that it is doubtful whether any advantage in understanding the system dynamics is obtained.

As a final demonstration a somewhat more complicated model is shown in Fig.10. This is the Chen &Aihara (1995) proposition for a transiently chaotic neuron.



$$\dot{a}_j = k_{1j}\,(b_{1j} + \sum_{i=1}^{n} x_i w_{ij}) + (k_{2j} - 1)a_j + z_j(y_j - b_{2j})$$

$$\dot{z}_j = 1 - z_j / k_{3j}$$

$$y_j = s_j(a_j) = k_4 / (1 + \exp(-k_5 a_j))$$

Fig.10. "Transient chaotic neuron" model (Chen and Aihara, 1995)

3. CONCLUDING REMARKS

The generic symbolism and the specific kind of block diagram representation presented in this study, has made possible the uniform representation of models for comparative studies. The use of simple component processes introduces a different understanding of neuronal modeling through graphical visualization. This enables one to reach an alternate understanding of the structure of a model and thus achieve a deeper appreciation of the relation between structure and dynamics. This structuring would also enable an easy simulation of these models by means of a computer-aided package.

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NOTATION

Notation is kept as simple as possible by employing operators such as summators, multipliers, functionals, derivatives and integrators.

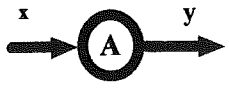
Bold-Italic parentheses *(·)*, denote a functional relationship e.g. $y=f(x)$. Bold letters denote matrices (upper case) or vectors (lower case). Normal letters denote scalars or elements of vectors and matrices.

All variables are considered to be functions of time [i. e. $x \equiv x(t)$]

[ ] Denotes an entry for an operation. e. g. $x \rightarrow \boxed{k+\int[\,]dt+d[\,]/dt} \rightarrow y=kx+\int x dt+dx/dt$

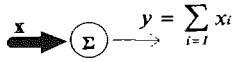
where k is a constant.

In the block diagrams, a thick arrow signifies a batch of signals, mathematically expressed as a vector.

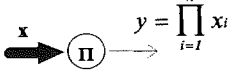


The diagram on the left denotes a *general accumulator* in which the value (or some other important parameter of interest such as the colour or the odour intensity) of the output $y(t)$ grows or shrinks with time according to some specified rule.

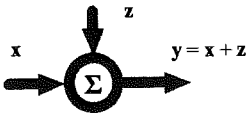
Different operators are represented as shown below.



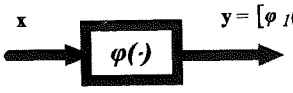
$\{\mathbf{x} \in R^n \text{ and } y \in R\}$ *(Summator)*



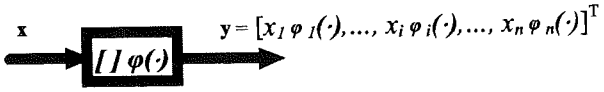
$\{\mathbf{x} \in R^n \text{ and } y \in R\}$ *(Multiplier)*



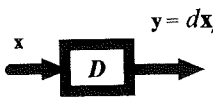
$\{\mathbf{x}, \mathbf{y} \text{ and } \mathbf{z} \in R^n\}$



$\{\mathbf{x}, \mathbf{y} \in R^n\}$

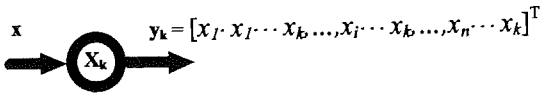


$\{\mathbf{x}, \mathbf{y} \in R^n\}$



$\{\mathbf{x} \text{ and } \mathbf{y} \in R^n\}$ *(Differentiator)*

$\{\mathbf{x} \text{ and } \mathbf{y} \in R^n\}$ *(Integrator)*



$\{\mathbf{x} \in R^n \text{ and } y \in R^{\binom{k}{n}}\}$

That is, $\mathbf{y}_k$ has elements which are all the possible products of the elements of $\mathbf{x}$.

In the special case of $k = 0$, $\mathbf{y}_0 = 0$ and for $k = 1$, $\mathbf{y}_1 = \mathbf{x}$.

THE ROLE AND IMPORTANCE OF THERMAL INSULATION IN HEATED BUILDINGS IN CYPRUS

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INTRODUCTION

The principal purpose of using thermal insulation in buildings is to reduce the winter heat losses and the summer heat gains and therefore create and maintain a thermally comfortable environment throughout the year. In the case of heated buildings, the use of thermal insulation plays an important role and offers the following benefits:

- It reduces the building heat losses and results to considerable energy savings
- It maintains higher surface and intersurface temperatures in the building structure
- It alleviates the risk of surface condensation
- It changes the thermal capacity and hence the thermal response of the building

EFFECT ON HEAT LOSSES

The fabric heat losses through a building structure, including walls, ceilings, floors, windows, doors, etc., are calculated from the equation:

$$Q = U \times A \times \Delta\theta$$

where, Q are the heat losses in Watts, U is the overall heat loss coefficient in W/m^2 °C, A is the surface area of the building element in m^2, and $\Delta\theta$ is the difference between the room and the ambient air temperature in °C. In order to keep heat losses at minimum, it is desirable to keep the U-value as low as possible. The value of the heat loss coefficient depends on the nature and the thickness of the building material and it is calculated from the equation:

$$U = \frac{1}{R_{si} + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \ldots\ldots + \frac{x_n}{k_n} + R_{so}}$$

where, x_1, x_2, ... x_n are the thicknesses of the various materials of the building component, in metres, k_1, k_2, ... k_n are the thermal conductivities of the materials respectively, in W/m K and R_{si} and R_{so} the surface thermal resistances for the inside and outside surfaces of a building element respectively. It is clearly seen in the above expression that the U-value of a building component can be reduced if appropriate materials having low thermal conductivity and large thickness are used.

The thermal conductivity of a building material depends on its density, the nature and pressure of the gas contained in the material cells and its content in moisture. The higher the moisture contained in the material the greater will be the thermal conductivity as a result of the fact that the thermal conductivity of water is much higher than that of dry still air. Generally speaking, a content of moisture 1% by volume may cause an increase in thermal conductivity by 0.0015 W/m K.

In Table 1, showing the values of thermal conductivities for different groups of materials, it is seen that gases in general have lower thermal conductivity, followed by liquids and solids. The low value of thermal conductivity in gases is actually the reason for which they are used in combination with other materials for the manufacture of the so called insulating materials.

Table 1. Thermal Conductivity of different groups of materials at 20° C (W/m K)	
Gases at atmospheric pressure	0.006-0.18
Insulating materials	0.020-0.25
Liquids	0.1-1.0
Solid non metallic	0.025-3.0
Metals	10-400
Dry still air	0.025
CO_2	0.017
Trichlorofluoromethane (CFC11)	0.008

As mentioned before, the thickness of insulation is another factor which also affects the U-value of a building component. As the thickness increases, the heat loss coefficient decreases resulting to a reduced heat loss through the building component. This is clearly demonstrated by the graph of fig. 1 which shows the effect of thermal insulation thickness on the heat losses of a house in Nicosia, heated at 20°C.

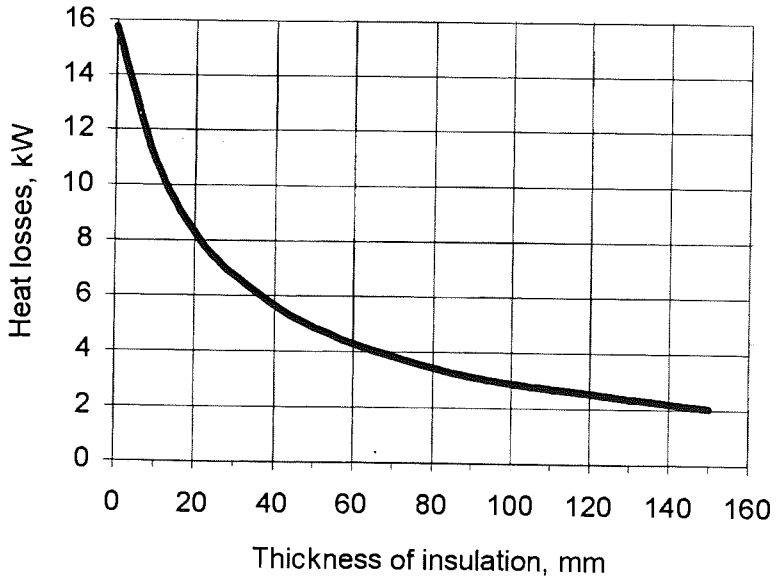

Fig. 1. Effect of thermal insulation thickness on the building heat losses

It is clearly shown that the heat losses decrease as the thickness of insulation increases. The addition of 20 cm thick insulation on the building structure, for example, results to a 50% reduction in the building fabric heat losses. The rate of reduction however decreases as the thickness increases, thus for a further increase in the thickness of insulation by 20 cm there is a further reduction of 15% in the heat losses.

OPTIMUM ECONOMIC THICKNESS OF INSULATION

It is clearly seen from fig. 1 that the heat losses from a building can be significantly reduced by the use of thermal insulation and that greater thickness of insulation results to reduced heat losses and consequently reduced energy bills. However, an increased thickness will cause an increase in the capital cost. It is therefore necessary to investigate the optimum economic thickness of insulation, that is the thickness of insulation which results in the minimum total annual cost. It depends upon the cost of the insula-

tion, the cost of fixing the insulation, the savings in fuel which results and the period over which the initial cost is to be recovered.

Fig. 2 is an example of the investigation of the optimum economic thickness of expanded polystyrene insulation used in a typical brickwall in Cyprus, similar to that illustrated in fig. 4 (left). Under the conditions assumed in the present study (cost of expanded polystyrene insulation panels 45 CY pounds per m^3, lifetime 30 years, cost of thermal energy 1.3 cents per kWh), the optimum economic thickness of insulation is about 40 cm.

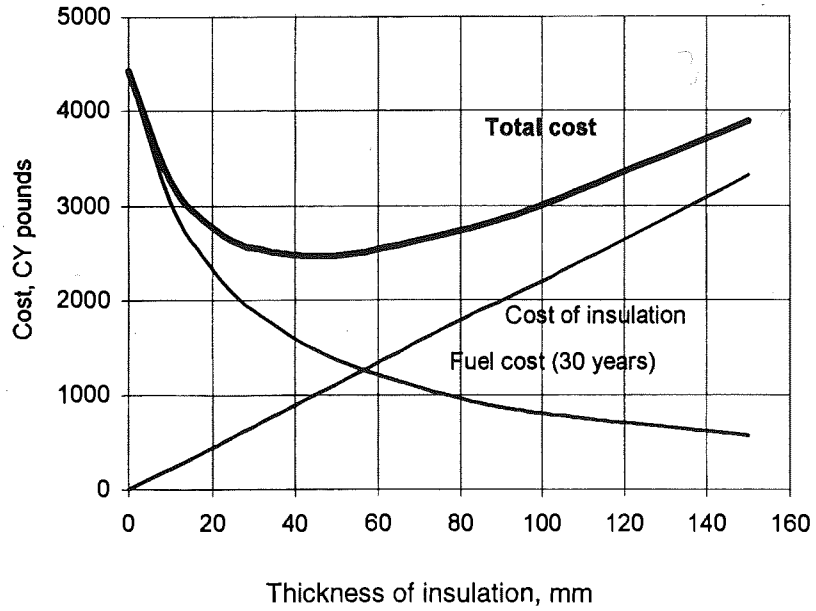

Fig. 2. Optimum economic thickness of insulation (expanded polystyrene)

The same procedure was used to investigate the optimum economic thickness of insulation for extruded polystyrene assuming the same conditions as above except for the cost which was taken as 90 CY pounds per m3 of insulation. The optimum economic thickness of insulation in this case is smaller than that of expanded polystyrene, because of its higher cost, and is approximately 25 cm (see fig. 3).

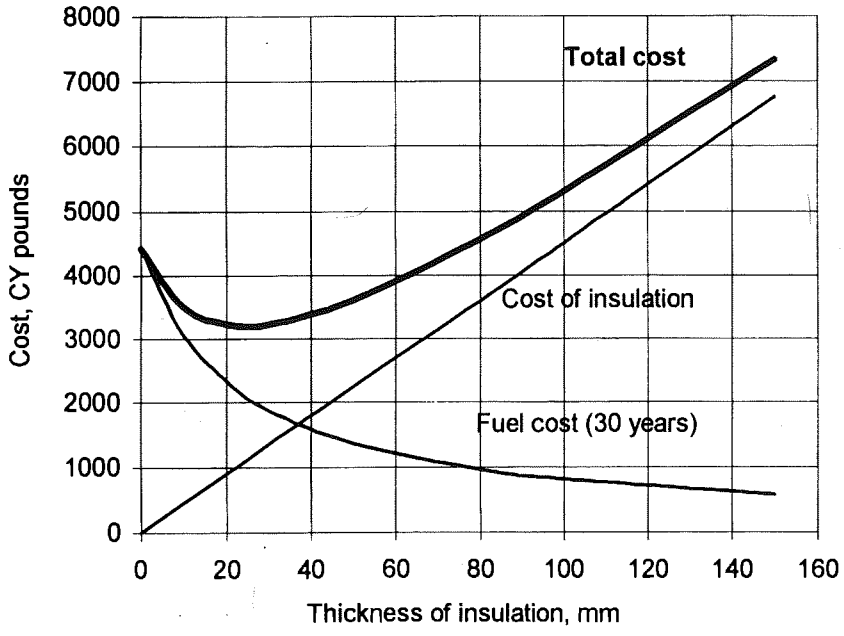

Fig. 3. Optimum economic thickness of insulation (extruded polystyrene)

HIGH SURFACE TEMPERATURES

It is well known that the radiant temperature of an environment and in effect the surface temperature of a wall or any other building structure, is one of the factors which affect the thermal comfort of the environment. Even if the room air temperature is satisfactory, the surface temperatures of the walls, floors and ceilings must be kept at about the same level as that of the room air temperature for a comfortable thermal environment in the room. This is achieved by using thermal insulation and it is demonstrated in fig. 5 which shows the temperature gradient through a typical 20 cm brickwall plastered in both sides by 25 mm thick lightweight plaster (left), and an insulated wall made of two layers of brick 10 cm thick and 5 cm of expanded polystyrene in between, plastered on the inside and outside surfaces by lightweight plaster (right). A comparison of the two walls shows that the inside surface temperature in the case of the insulated wall is 18.8 °C as compared to 16.6 °C for the single brickwall, for an indoor and outdoor design temperature of 20 °C and 0 °C respectively.

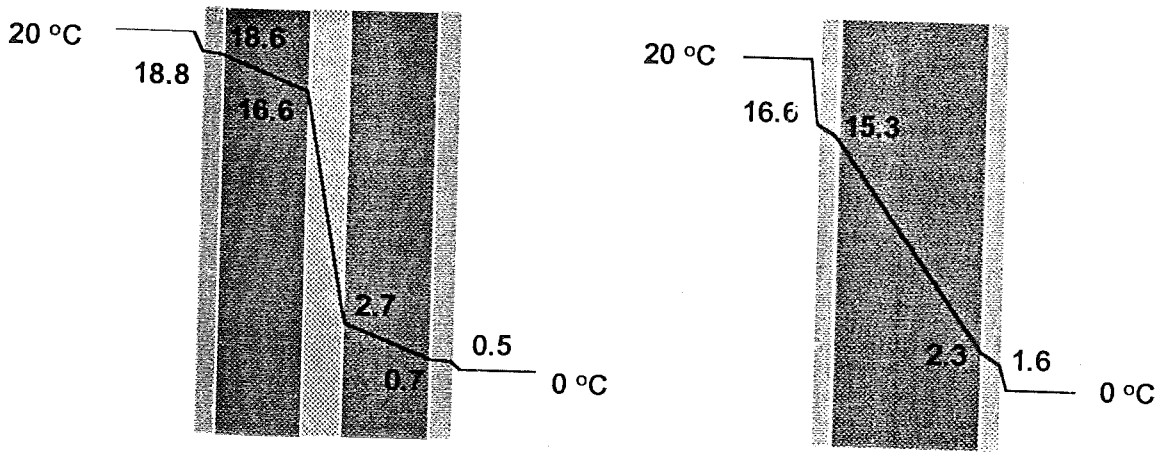

Fig. 4 Temperature gradient through an insulated brickwall (left) and a non-insulated brickwall (right)

ALLEVIATION OF THE RISK OF SURFACE CONDENSATION

Surface condensation occurs when moisture contained in the air is in contact with a surface which has a temperature below the dew point temperature of the air. If therefore, the probable dew point temperature of the air is known, the wall can be insulated to prevent surface condensation, since the insulation has the effect of raising the wall inside surface temperature (see fig. 4).

EFFECT OF INSULATION ON THERMAL CAPACITY

The thermal capacity of a building component is an indication of the amount of thermal energy which can be stored into the building structure in the steady-state condition and may be determined for each component of the structure by means of the following expression:

$$\Phi = M\, c\, \Delta T$$

where, î is the thermal capacity of the structure (J), M is the mass of structure (kg) and ΔT is the difference in temperature between the mean temperature of the structure and the datum temperature for unit difference between the inside and outside surface temperatures (°C).

As a result of the fact that the surface and intersurface temperatures in an insulated wall are higher than those of a non-insulated wall, the difference between the mean temperature of the structure and the da-

tum temperature for the insulated wall is greater than that of the non-insulated wall, which in effect results to a higher thermal capacity.

Fig. 5 is an example which demonstrates the effect that thermal insulation has on thermal capacity. It shows the temperature gradient for three different scenarios which represent a non- insulated brickwall, an insulated wall with the insulation fixed on the inside surface and a third scenario with the insulation fixed on the outside surface. The heat loss coefficient is certainly lower in the case of insulated walls but it does not make any difference if the insulation is fixed on the inside or the outside surface. The situation however, is different for the thermal capacity. For the conditions of indoor and outdoor design temperatures assumed (20 and 0 °C respectively), the thermal capacity of the structure is 2032 kJ/m^2 of surface area when the insulation is fixed on the outside surface as compared to only 554 kJ/m^2 when the insulation is fixed on the inside surface and 1017 kJ/m^2 without any insulation. To a great extent, this is due to the difference in surface and intersurface temperatures.

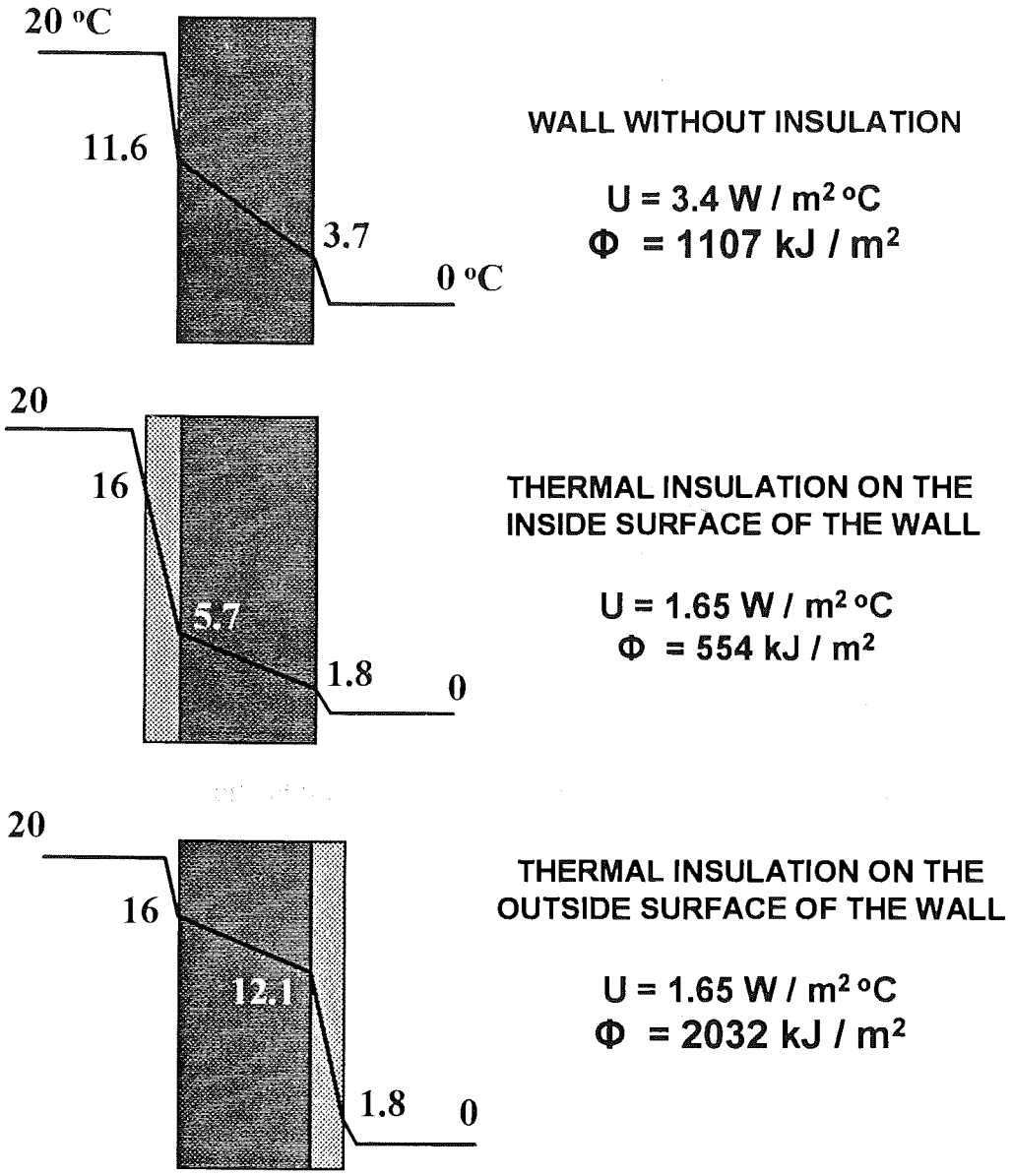

Fig. 5. Effect of thermal insulation on the thermal capacity of a wall

CONCLUSIONS

The purpose of this presentation was to identify the benefits from using thermal insulation in heated buildings under the weather and economic conditions of Cyprus. An attempt was made to investigate the optimum economic thickness of insulation for two insulating materials, based on certain economic parameters (cost of buying and fixing the insulation, cost of energy, etc).

It has been proved that for a heated house in Cyprus, the use of thermal insulation not only improves thermal comfort but also results to considerable energy savings. What is needed is a detailed study for the investigation of the optimum economic thickness for different insulation materials and wall configurations used in Cyprus. The study should also cover roofs, windows and other building components.

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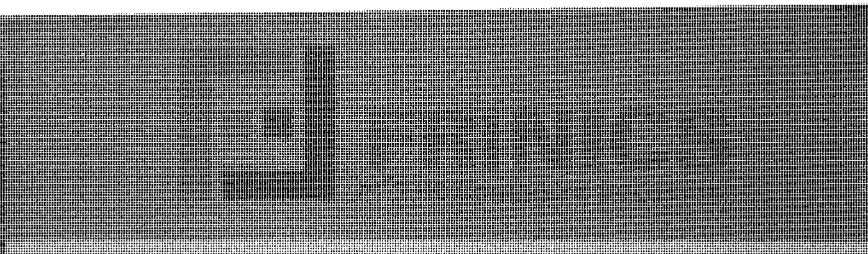
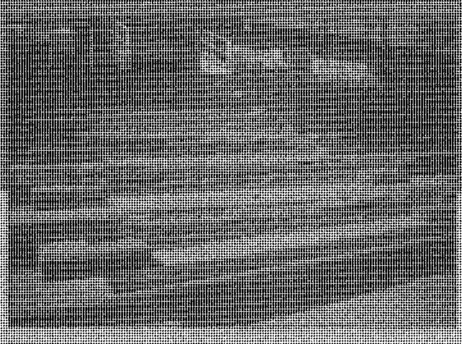
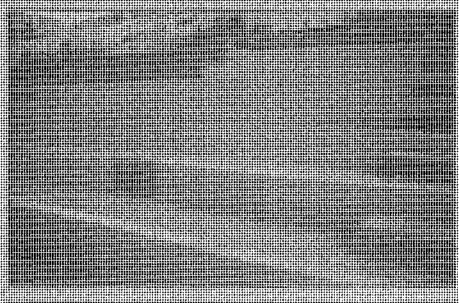
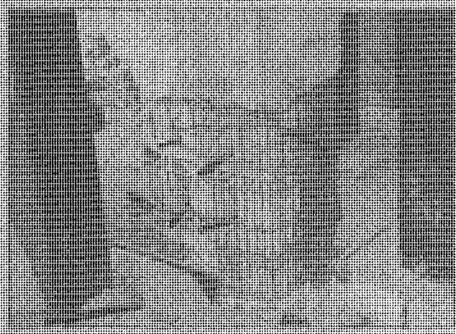






ΛΕΣΧΗ ΙΠΠΟΔΡΟΜΙΩΝ ΛΕΥΚΩΣΙΑΣ



Με την ευκαιρία του πρόσφατου σεμιναρίου που διοργανώθηκε στην Πάφο με θέμα:
"ΕΠΙΣΚΕΥΕΣ ΚΤΙΡΙΩΝ ΑΠΟ ΟΠΛΙΣΜΕΝΟ ΣΚΥΡΟΔΕΜΑ & ΛΙΘΟΔΟΜΕΣ ΒΛΑΜΜΕΝΩΝ ΑΠΟ ΣΕΙΣΜΟ",
με επίσημο χορηγό την εταιρία μας, θα θέλαμε να σας ευχαριστήσουμε για την παρουσία σας.

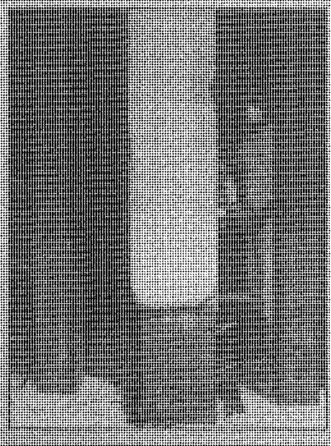
Η σημασία της διοργάνωσης του σεμιναρίου αυτού ήταν διπλή. Από την μια, η σπουδαιότητα του θέματος και οι ενδιαφέρουσες εισηγήσεις των ομιλητών και από την άλλη η μερική διαφώτιση των διαφόρων υλικών που υπάρχουν στην κυπριακή αγορά.

Ελπίζουμε ότι η σχέση αυτή που έχει ξεκινήσει μεταξύ των μελών του **ΣΠΜΑΚ** και της εταιρίας μας θα συνεχιστεί πάνω σε μια μόνιμη και συνεχή βάση.

Εμείς, από τη πλευρά της εταιρίας **FRINICS LTD** σας διαβεβαιούμε ότι θα συνεχίσουμε ακούραστα να προσφέρουμε τις υπηρεσίες μας οποτεδήποτε εσείς χρειαστείτε.

Μετά τιμής,

Γιάννης Παπαϊωάννου
Γενικός Διευθυντής



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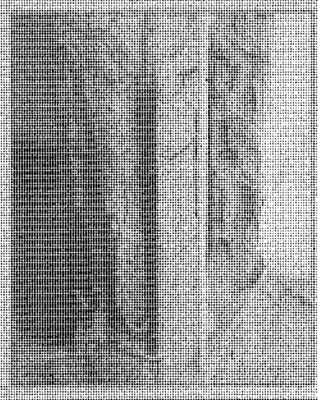

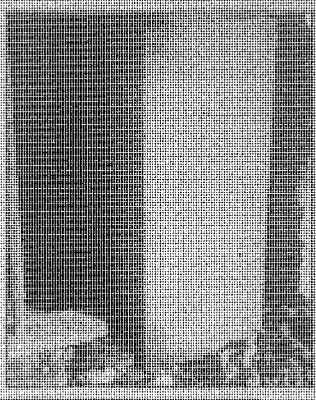

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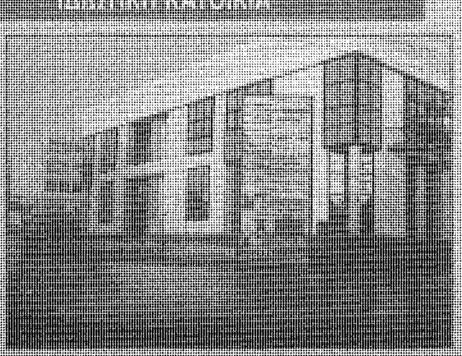

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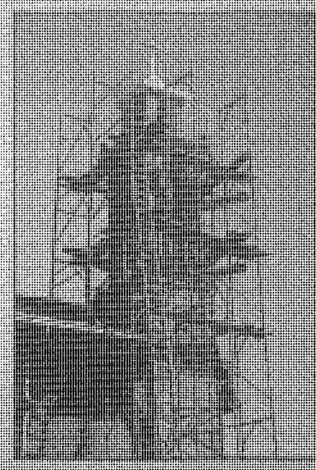

ΕΚΚΛΗΣΙΑ ΣΤΙΣ ΓΕΡΑΚΙΕΣ

WASTEWATER REUSE - SOIL REACTIONS IN TERMS OF pH

N. Kathijotes, B.S.C.E., M.S.Env. E, Lecturer, Department of Civil Engineering, HTI.

INTRODUCTION

With many countries facing severe water shortages, reusing water for irrigation and industrial purposes is becoming more favourable.

In planning and implementation of water reclamation and reuse, the intended water reuse application dictate the extend of wastewater treatment required, the quality of the finished water and the method of distribution and application.

Cyprus with a total surface area of 9250 Km^2 due to its semiarid climate faces a problem of inadequacy of water for both its domestic and irrigation needs.

The mean annual rainfall over the island is 500 mm which corresponds to 4600 million cubic meters of water over its total area.

Due to the aridity of the region a proportion of about 80% of the rainfall returns to the atmosphere as loss by evaporation and evapotranspiration .

If a balance is carried out of the water resources of Cyprus then in the incomming, one may incude the mean annual crop of 900 million cubic meters which can be analyzed into 67% surface runoff and 33% groundwater whilst in the outgoing, one may include 37% of losses in the sea, 30% pumpage and flow from springs, 21% mean annual yield of the dams and 17% as diversions for spade irrigation from the streams.

In Cyprus there are no permanent surface water streams or lakes but until some years ago, underground water resources were adequate to meet the local water demand.

However overexploitation of the underground water lead to a gradual decrease of groundwater resources.

The reuse of sewage effluents however should be seriously considered as an important strategy in conserving water resources.

EXPERIMENTING WITH WASTEWATER REUSE

Soil samples were taken from an area which was irrigated with treated effluent for about eleven years. Plots in this area were also irrigated with fresh groundwater.

Samples were taken from both irrigation plots at intervals of 10cm to a depth of 1.20 m.

The location selected was in Aglandja area, the farm of the Agricultural Research Institute.

The soil in this area is characterised as Saltic Fluvisols, and its content was homogeneous throughout all profile.

The clay content varied from 20.2 to 22.4 percent with high sand content.

We can therefore define it as sandy- clay loam. They are poor in organic matter content 1% but rich in general carbonate (CO_3), 16-19%.

Therefore their pH is high 8.92-9.87 which shows alkalinity characteristics.

In these soils only crops with high pH tolerance can grow.

As previously mentioned two types of water were used for irrigation.

1. Fresh ground water from three nearby wells

2. Treated wastewater (secondary stage)

CHARACTERISTICS OF FRESH GROUND-WATER USED

The following were the major characteristics of the water used:

- high content of soluble elements toxic to agriculture
- electric conductivity = 3.0 mmho/cm
- from the cations predominant is Na+=21.7 mg/l
- from the anions predominant is Cl = 15.5 mg/l

It should be noted that Na_2CO_3 is one of most toxic to crops.

CHARACTERISTICS OF TREATED EFFLUENTS USED

Content similar to fresh ground water but contains additional elements and salts toxic to crop.

Electric conductivity = 3.7 mmho/cm
High in Na^+, Cl, CO_3 and high pH upto 9.2

SIGNIFICANCE OF pH INVESTIGATION

Perhaps the most outstanding characterestic of soil solution is whether it is acidic, alkaline or neutral.

Microorganisms and higher plants respond markedly to soil reactions because they tend to control so much of their chemical environment.

Soil acidity is common in all regions where precipitation is high enough to leach appreciable quantities of exchangeable base-forming cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) from the surface layers of soils.

Alkalinity occurs when there is a higher degree of saturation with base-forming cations. The presence of calcium, magnesium, and sodium carbonates can also result in a predominance of hydroxy ions over hydrogen ions in the soil solution which enhance alkalinity. If sodium carbonate is present a pH of 9 or 10 may be reached in some soils.

Alkaline soils are, of course, characteristic of arid and semi-arid regions like Cyprus.

EXPERIMENTAL RESULTS - pH EVALUATION

The obtained results in terms of pH are shown on Figure1.

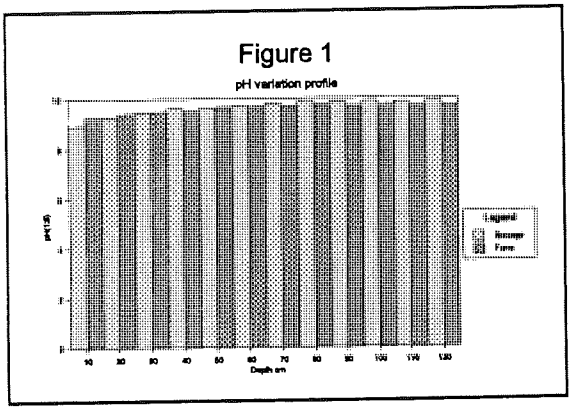

Figure 1

For every 10 cm increment a bar shows firstly the pH of soil irrigated with treated effluent and secondly the soil pH irrigated with ground water.

One can immediately observe the high pH values of all profile.

It is also evident that greater effects on soil occurs at depths upto 50 cm.

The values below 50 cm are more or less steady.This shows the interarractions that occured at the initial 50 cm between, soil , water and plant roots.

Plant roots absorb more ingredients from treated sewage which had a lower pH at its fresh stage as it was used for domestic supply.

At both cases however of fresh water and treated sewage a washout of alkalinity could have occured due to rainfall at the upper layers which consequently demonstrate lower pH values.

MANAGEMENT OF SALINE AND SODIC SOILS

As high pH values associated with sodic soils and high pH irrigation water limit the growth of crop, and in view of the increased demand for using treated wastewater in Cyprus which is considered as a semi-arid zone, proper management for this valuable resource is important.

Three kinds of general management methods have been used to maintain or improve the productivity of saline and sodic soils.

The first is removal of the salts, the second is a conversion of some salts to less injurious forms and the third is designated as control, through various agricultural methods.

In practice it would be easy to understant if we say that a leaching procees, that is washing the salts away through flooding with clean fresh water and preferably rain water would be ideal solution, but this can be considered as a remote possibility in dry areas.

Carefull use of animal manure could be a good solution in the reduction of pH as the acids formed during the decomposition of this manure assist in this direction.

In the conversion method referred above,the use of gypsum is commonly recommended for the purpose of exchanging Ca^{2+} for Na^{+} on the micelle and removing bicarbonates from the soil solution.

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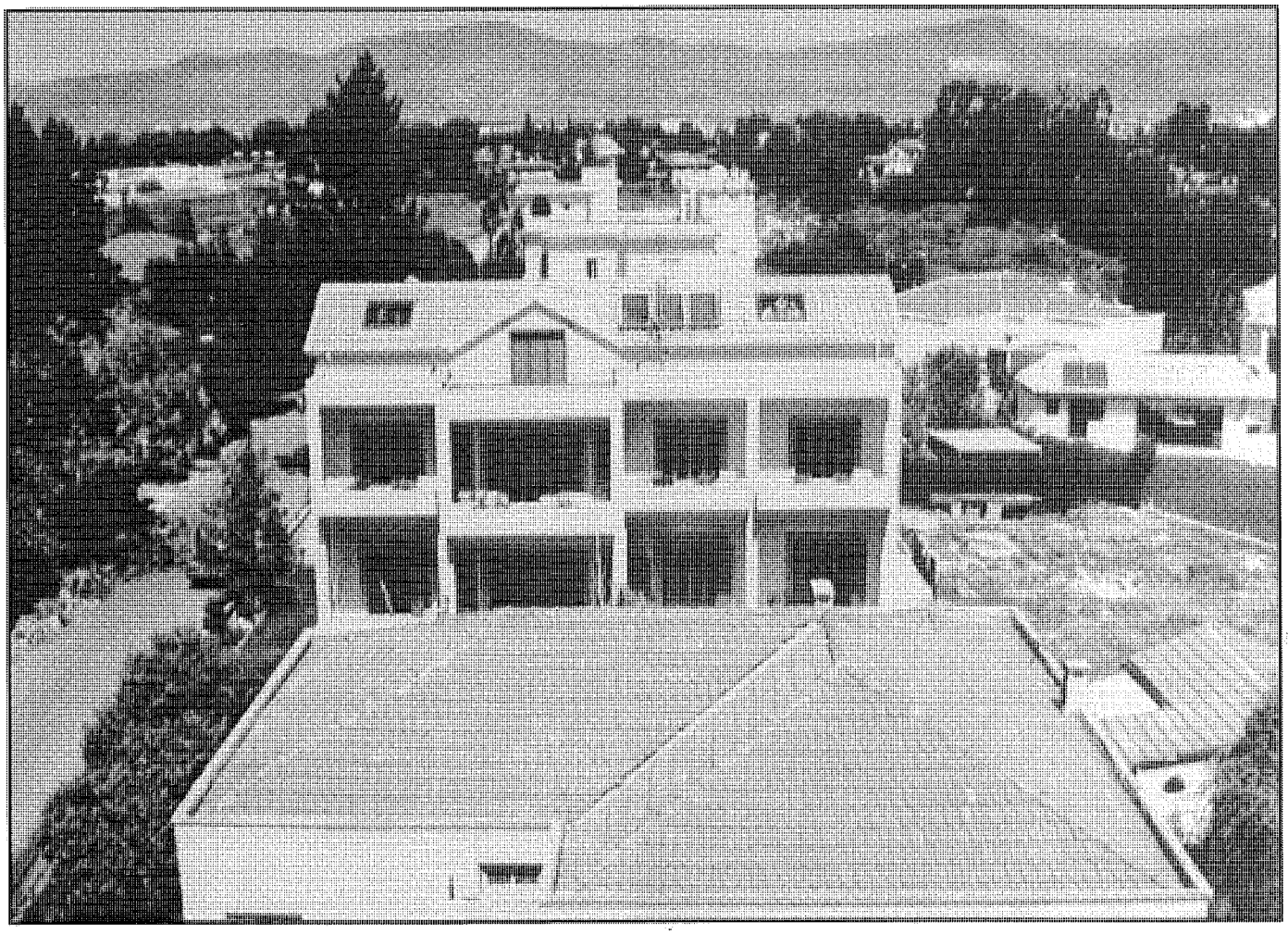


PROTOTYPE SOLAR HOUSE FOR CYPRUS

Dr. Despina Serghides, AA Dipl., RIBA II, AA Grad., PhD.
ISES - Cyprus President, Senior Lecturer, Department of Civil Engineering, HTI.

The Higher Technical Institute (HTI) having developed the idea of designing a prototype solar concept formed a technical team from its staff and the writer,as the resident architect and cordinator of the team and Dominic Michaelis (UK) as the external consultant architect.

The prototype solar house designed for a family was intended to appeal to the island's largest possible single population group, those who could afford a house containing as many solar elements as might be technically cost effective and in which there is greater potential for energy saving.

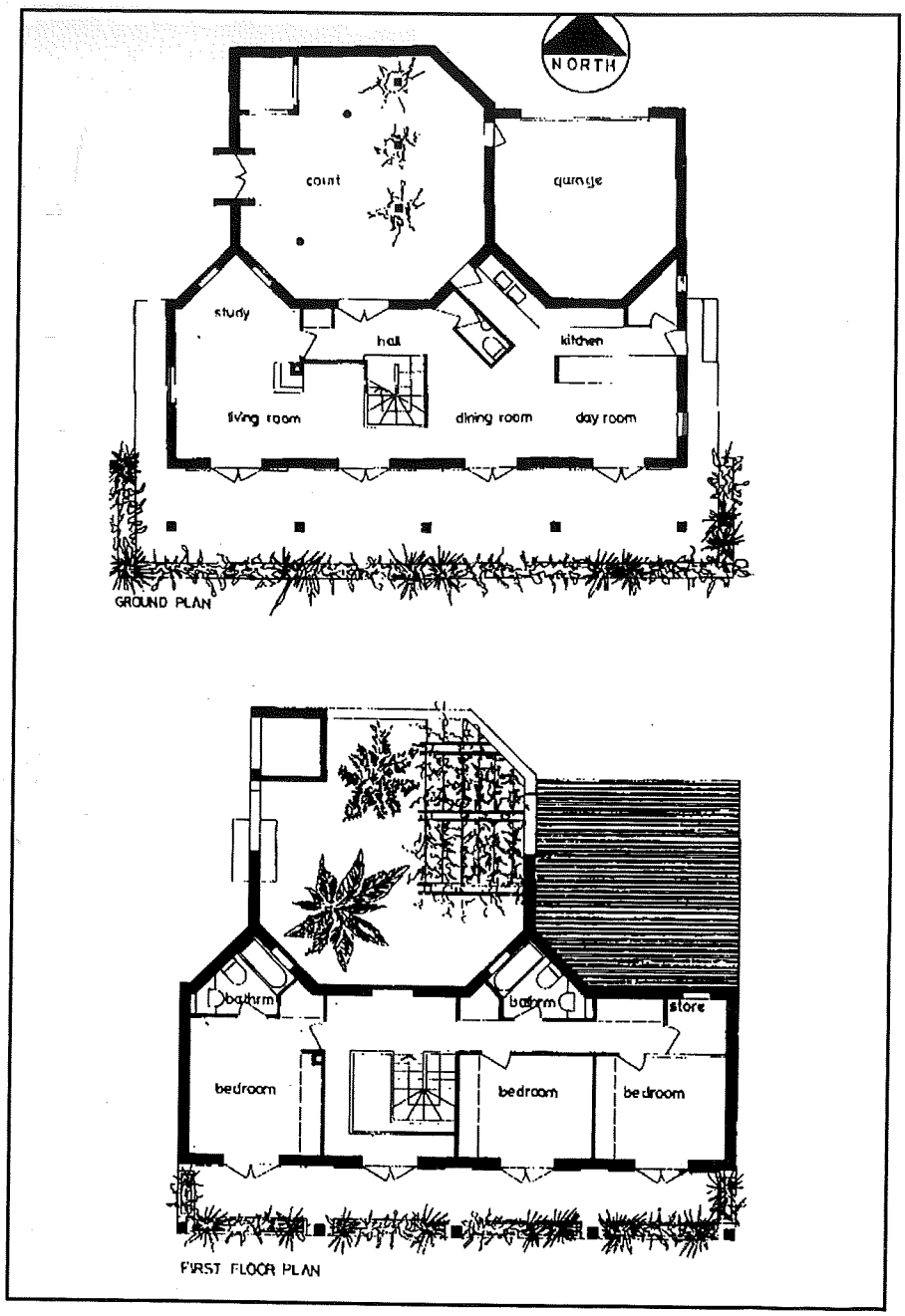
It was an effort to promote, motivate and convince people to erect residential buildings, which are low energy consumers, but at the same time comfortable during both in summer and winter. The initiative was further intended to become the starting point for the utilization of the natural resources of energy, especially solar energy, beyond the solar collectors which are extensively used on the island.

Design description

The Mediterranean climate, although mostly mild,requires both the heating and cooling of buildings to varying degrees. Therefore throughout the design process,the aim was to maximise heat gain in winter, minimise it in summer, encourage heat losses in the summer and limit them in winter.

Siting the building

Before the building was sited a study was made of the site both under existing built conditions and taking into account future extensions and development which may be governed by regulations. The predominant wind patterns,their direction and



intensity, determined the land-scaping for buffering and shading effect on the building.

Shape and orientation

The building is a basic L-shape with the courtyard on its west side, protecting from prevailing cold winds.

The house is designed on a long east-west axis with its glazed facade facing south, enjoying abundant solar radiation in winter. It has compact wall areas on the east and west and a sloping roof thus avoiding the sun which rises and sets at a large azimuth in the summer.

Layout of the building

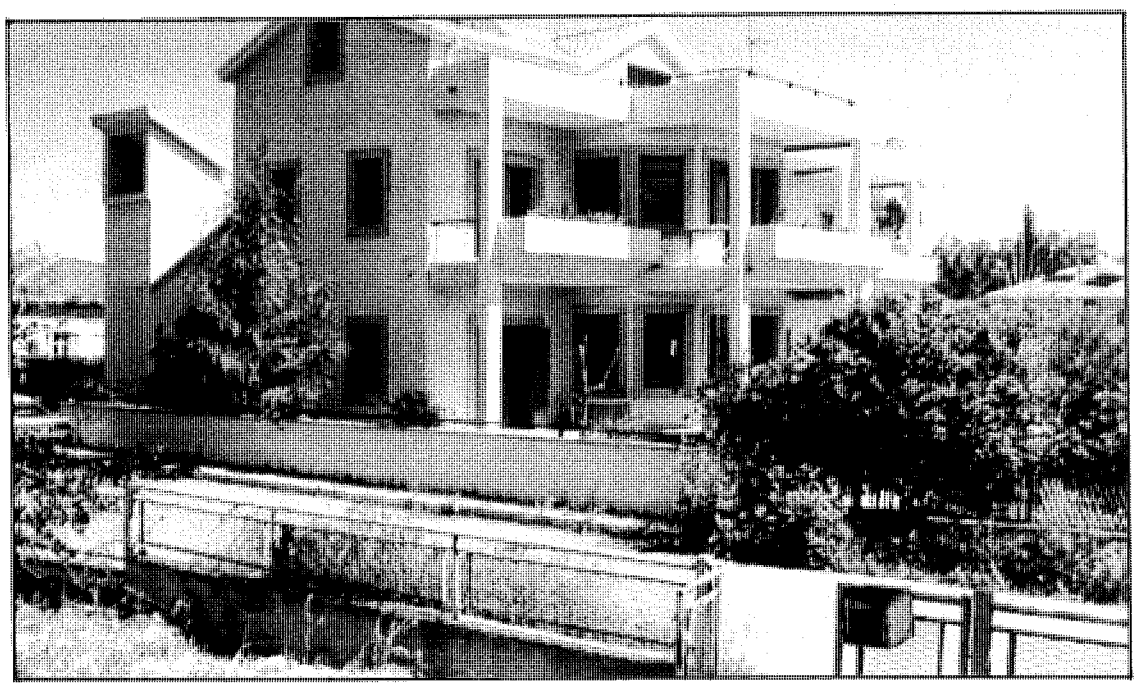
Main Rooms such as the dining room, sitting room, playroom and bedrooms have large glazed openings and are located along the south facade, ensuring more solar radiation for longer periods in winter.

Secondary Rooms such as the kitchen, bathroom and toilets and store rooms are placed on the northern side, with openings on it to achieve cross-ventilation. The corridors both on the ground and upper floor act as buffer zones to the cold north winter winds.

The sunspace extends from the ground to the upper floor, exposing as many glazed sides to winter sun as possible, taking the shape of a polygon and protecting its glazed area from the summer sun by projection of its roof structure and the use of timber shutters. Winter heat losses are restricted further to the shutters by curtains and proper weather stripping and detailing.

The main entrance lobby is located on the northern elevation of the house, protected by the enclosed courtyard. It is deliberately designed to form a closed space so as to act as a buffer to cold north winter winds when the entrance door opens.It increases the resistance to infiltration between the entrance door and the inner frame of the house. The sequence of closing one door before opening the second one prevents direct air exchange between indoors and outdoors. The use of glazed panel for a see-through view when entering the lobby enhances the architectural quality of interlocking spaces.

The semi-elliptical staircase in the open gallery, besides its spatial and light considerations, contributes to natural ventilation by stack effect. Hot air naturally rises to the upper floor so that warmth can be distributed to the bedrooms in winter. In summer, when the hot air is undesirable, the loft opening acts as its escape exit and it is replaced by the cool air entering the house from the courtyard.



The fire place is centrally located in the living room. In winter, when it is not in use, hot air is prevented from escaping through the chimney with the aid of a damper, whereas in summer when ventilation is required, the chimney encourages it through the stack effect.

The patio-courtyard accessible from the road with the entrance of the house through it, is used as a recreation space, offering a pleasant transitional environment from the outside to the inside and at the same time allowing the occupants to retain their privacy.It is located to the north of the building. The courtyard acts as a cold north wind barrier and provides a secluded, protected approach to the house in winter. In summer, in combination with the wind tower, it forms an effective configuration for cooling.

A large deciduous tree in the courtyard provides shade and retains moisture in the dry heat of the summer day. In addition to the tree, a pergola with deciduous climbing plants is intended to provide similar cooling and shading effect.

A wind tower is the main feature of the courtyard, enhancing its cooling effects. It is located at the northern side of the courtyard. It is 7m high and to admit the summer breezes it has an opening to the west side designed in such a way as to channel the air downwards. This air passes over the spray of a fountain which has the effect of cleaning it of dust and cooling it before it enters the courtyard. In winter when the wind is undesirable, inside flaps act as barriers. The courtyard provides a pleasant environment as a sitting area, with all the attractions of the traditional courtyard with its multi-purpose functions. Adjoining the kitchen it is also offered as an outdoor barbecue and dining space during summer, and on sunny winter days.

The garage is attached to the northern side of the house and encloses the courtyard on its east side. Positioned in this way,it protects the house from the cold north wind and restricts heat losses from this side. A door from the garage to the courtyard,near the kitchen, provides easy access to it. Its flat slab roof is offered as a large verandah, accessible from the upper floor and from the courtyard by a flight of stairs.

The covered balconies are extended on the south facase of the building, acting as shading devices of the glazing and the verandahs of the ground floor. The depth of the roof extension, which covers and projects over the verandahs below, was desighed so as to admit the winter sun, but to prevent it from entering the glazed facade in summer. In this way the balconies and the verandahs are offered as pleasant sitting areas for the sunny winter days and the cool summer nights when breezes blow from south-southwest.

The elements of the house were designed and detailed appropriately with insulation, mass and other necessary considerations so as to utilize the natural resources of energy available on the site in order to achieve indoor comfort for both summer and winter. ■

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INTEGRATED COLLECTOR STORAGE SYSTEM DESIGN AND CONSTRUCTION

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ABSTRACT

The design and construction of an Integrated Collector Storage (ICS) system is presented in this paper. The main advantage that such a collector system presents with respect to the conventional flat-plate collectors is the fact that it is of a very low profile. The main disadvantage of these collectors comes from the design of the system i.e. because the receiver of the collector is also the storage vessel, it is not possible to insulate it properly and there are significant heat losses during the night. System optimisation is carried out by the use of a computer code written for the purpose. The initial cost of the system presented here is 13% cheaper than the corresponding flat-plate (FP) collector of the same aperture area and storage volume. Additionally the economic analysis of the two systems, performed with the F-Chart program, showed a yearly F-value of 0.92 for the ICS system compared to 0.83 for the FP system, a payback time of 8 years for the ICS system compared to 11 years for the FP system, and Life Cycle Savings of £409 for the ICS system compared to £201 for the FP system.

INTRODUCTION

Low temperature water heating in Cyprus and in many parts of the world is usually satisfied by flat-plate thermosiphon solar collectors. The development of simpler and cheaper solar energy devices will help in the spread of solar energy as a means of producing hot water from renewable energy sources. Additionally, the main disadvantage of flat-plate collectors is the height which makes the units not very attractive aesthetically. In Cyprus this is even worse, because due to the frequent short term cuts in water supply, a cold water storage tank is installed on top of the solar collector supplying both the hot water cylinder and the cold water needs of the house.

The design of Integrated Collector Storage (ICS) units depends on operational characteristics of each application in relation to the environmental conditions of the particular site. ICS collectors are primarily used for domestic hot water production and are generally suitable for small scale applications in the range of 100-200 litres/day. As the area and range of application coincides with that of flat-plate collectors it is necessary to investigate the possible advantages that ICS units present against the flat-plate ones.

Domestic hot water thermosiphon type units employing flat-plate collectors present a number of operational and maintenance problems mainly due to corrosion (Kalogirou, 1996). The economics of the present system will be investigated later for comparison purposes.

The main disadvantage of the ICS systems is the high thermal losses from the storage tank to the surroundings since the greater part of the storage tank cannot be thermally insulated as it is also used for the absorption of solar radiation. In particular the thermal losses are greatest during the night and overcast days with low ambient temperature. Due to these losses the water temperature drops substantially during the night especially during the winter. For the construction of the ICS model the same area to volume ratio equal to that of a flat-plate collector was used i.e. 35 l/m^2, for comparison purposes.

DESIGN OF THE SYSTEM

The design of the ICS system has been carried out by considering a horizontal cylindrical tank which is at the same time the absorber and the hot water storage. Selective absorber surface is used for increas-

ing the absorptivity of the cylinder. Various types of ICS units are demonstrated in Tripanagnostopoulos and Yianoulis (1992). In this paper a different shape of collector curve is proposed.

It is desirable to have collectors that have a good overall efficiency with reduced heat losses. Concentrating collectors are of such type and this makes them suitable for high temperature applications. But it is also desirable to have concentrating collectors that can function satisfactorily with minimum requirements for tracking. One type of concentrator which has the capability of reflecting to the receiver all of the incident radiation within wide limits is the compound parabolic concentrator (CPC). Their potential as collectors of solar energy was pointed out by Winston (1974). These are more useful as linear or trough-type concentrators and any radiation entering the aperture within the collector acceptance angle, will be reflected to a receiver by specularly reflecting parabolic minors. The acceptance angle is defined as the angle through which a source of light can be moved and still converse at the receiver. The orientation of a CPC collector is related to its acceptance angle. A logical orientation for such a collector is along a horizontal east-west axis, sloped towards the equator at an angle equal to the local latitude. The minimum acceptance angle in this case should be equal to the maximum incidence angle projected in a north-south vertical plane during the times when output is needed from the collector. In practice bigger angles are used so as the collector is able to collect diffuse radiation at the expense of a lower concentration ratio.

Smaller (less than 3) concentration ratio CPC's are of greatest practical interest. These according to Pereira (1985) are able to accept a large proportion of diffuse radiation incident on their apertures and concentrate it without the need of a tracking mechanism.

The width to length ratio determines how much area is lost due to shading at off-normal conditions. For fixed volume to area ratios it also affects the amount of heat losses from the tank as the diameter to length ratio of the tank changes accordingly. For this purpose a computer program was written which simulates the system during energy collection period (day-time) and during the cooling-down period (night-time). The objective is to find the size of system which collects the maximum possible amount of solar energy whilst at the same time keeping the thermal losses to a minimum.

The optimisation was carried out by considering three different configurations as shown in Table 1. The results of the program are shown graphically in Fig. 1 where it can be seen that the configuration #1 gives the highest end of day storage temperature, the lowest next morning temperature, and the highest energy gain. Configuration #3 is exactly the opposite whereas configuration #2 is a compromise between the two and it was therefore selected.

Table 1. Collector configurations simulated for system optimisation

Configuration	Collector width (m)	Collector length (m)	Absorber diameter (m)
#1	0.80	2.5	0.18
#2	1.00	2.0	0.20
#3	1.33	2.0	0.24

- Notes: 1. Collector aperture = 2 m^2
  2. Absorber capacity = 65 litres

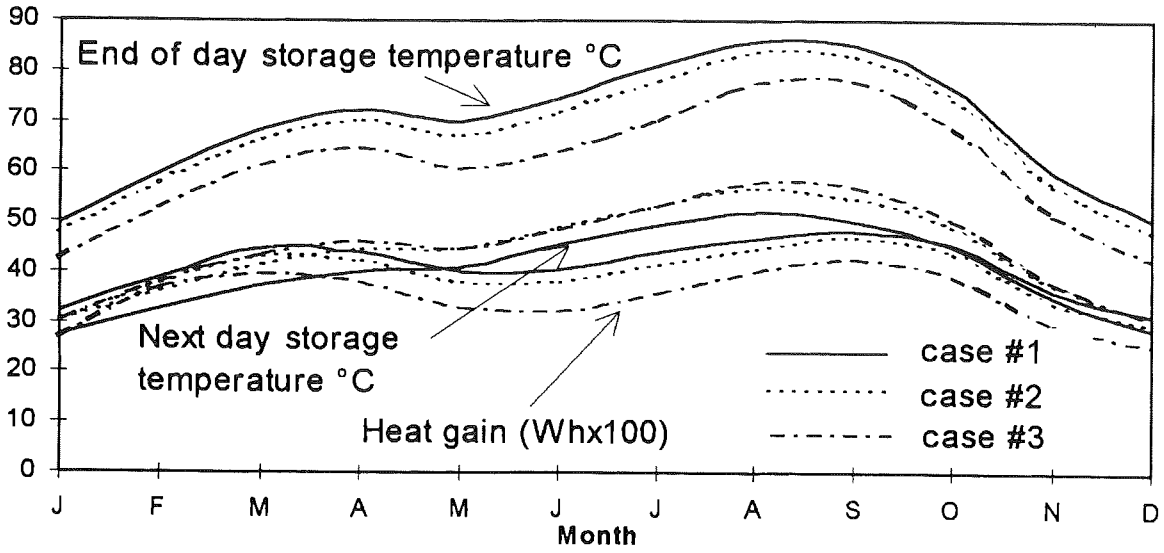

Fig. 1. Output from the simulation program

From the many shapes of the non-imaging CPC collectors the cusp type is chosen. A fully developed cusp concentrator for a cylindrical receiver is shown in Fig. 2. The particular curve illustrated has an acceptance half-angle, θ_A, of 60°, or a full acceptance angle, $2\theta_A$, of 120°. Each side of the cusp has two mathematically distinct segments smoothly joined at a point P related to θ_A. The first segment, from the bottom of the receiver to point P, is the involute of the receiver's circular cross section. The second segment is from point P to the top of the curve, where the curve becomes parallel to the y-axis (McIntire, 1979).

With reference to Fig. 3, for a cylindrical receiver the radius R and acceptance half-angle, θ_A, the distance, ρ, along a tangent from the receiver to the curve, is related to the angle Θ, between the radius to the bottom of the receiver and the radius to the point of tangency, T, by the following expressions for the two sections of the curve (McIntire, 1979):

$$\rho(\theta) = R\theta, \quad |\theta| \le \theta_A + \pi/2 \quad \text{(the involute part of the curve)}$$

$$\rho(\theta) = R\left\{ \frac{\{\theta + \theta_A + \pi/2 - \cos(\theta - \theta_A)\}}{1 + \sin(\theta - \theta_A)} \right\}, \quad \theta_A + \pi/2 \le \theta \le 3\pi/2 - \theta_A \qquad (1)$$

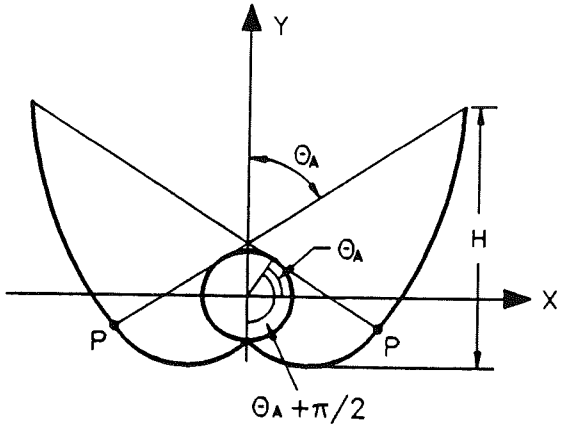

Fig. 2. Fully developed cusp

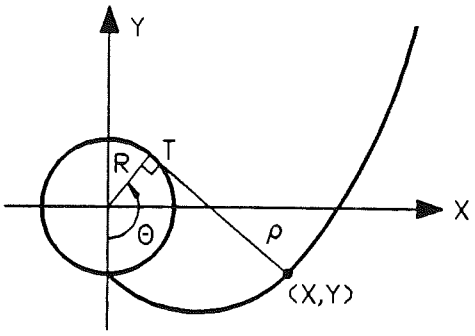

Fig. 3. Mirror coordinates for ideal non-imaging cusp concentrator

The two expressions for $\rho(\Theta)$ are equivalent for the point P in Fig. 2, where $\theta=\theta_A+\pi/2$. The curve is generated by incrementing Θ in radians, calculating ρ, and then calculating the coordinates, X and Y, by:

$$X = R \sin\theta - \rho \cos\theta$$
$$Y = R \cos\theta - \rho \sin\theta \qquad (2)$$

CONSTRUCTION OF THE SYSTEM

Figure 2 shows a full untruncated curve which is the mathematical solution for a reflector shape with the maximum possible concentration ratio. The reflector shape shown in Fig. 2 is not the most practical design for a cost effective concentrator, because reflective material is not effectively used in the upper portion of the concentrator. As in the case of the compound parabolic collector, a theoretical cusp curve should be truncated to a lower height and slightly smaller concentration ratio. Graphically, this is done by drawing a horizontal line across the cusp at a selected height and discarding the part of the curve above the line. Mathematically the curve is defined to a maximum angle Θ value less than $3\pi/2-\Theta_A$. The shape of the curve below the cutoff line is not changed by truncation, so the acceptance angle used for the construction of the curve (using Eq.1) of a truncated cusp is equal to the acceptance angle of the fully developed cusp from which it was truncated. A large acceptance angle of 70° is used in this design so as the collector would be able to collect as much as possible diffuse radiation. The fully developed cusp together with the truncated one is shown in Fig. 4. The receiver radius considered in the construction of the cusp is 0.24 m. The actual cylinder is 0.20 m. This is done in order to create a gap at the underside of the receiver and the edge of the cusp in order to minimise the optical and conduction losses. The actual acceptance angle of the truncated cusp for a receiver diameter of 0.20 m is 75°.

The final design of the collector is shown in Fig. 5 and photo 1. The dimensions of the low iron glass (purchased by a local flat-plate collector manufacturer) are 1.95x0.95 m. The collector width finally used is 0.925 m so as space remains at the collector edges for the fixing of the glass cover. The same is true for the two ends. Therefore the final collector aperture is 1.77 m^2 which in combination to the receiver diameter used gives a concentration ratio of 1.47.

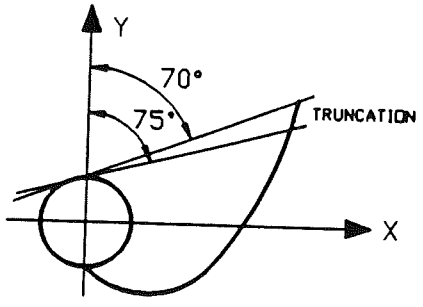

Fig. 4. Truncation of non-imaging concentrator

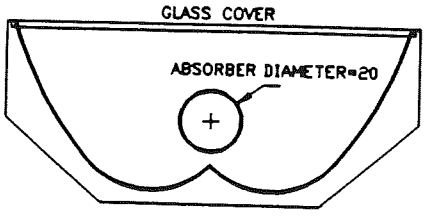

Fig. 5. The final collector

The side view of the collector which incorporates the cold water tank is shown in Fig. 6. The total height of the complete set-up is 1.35 m. This height exhibits a significant reduction as compared to a height of 3 m of the normal flat-plate collector system. A circular cold water tank would reduce the overall height even more.

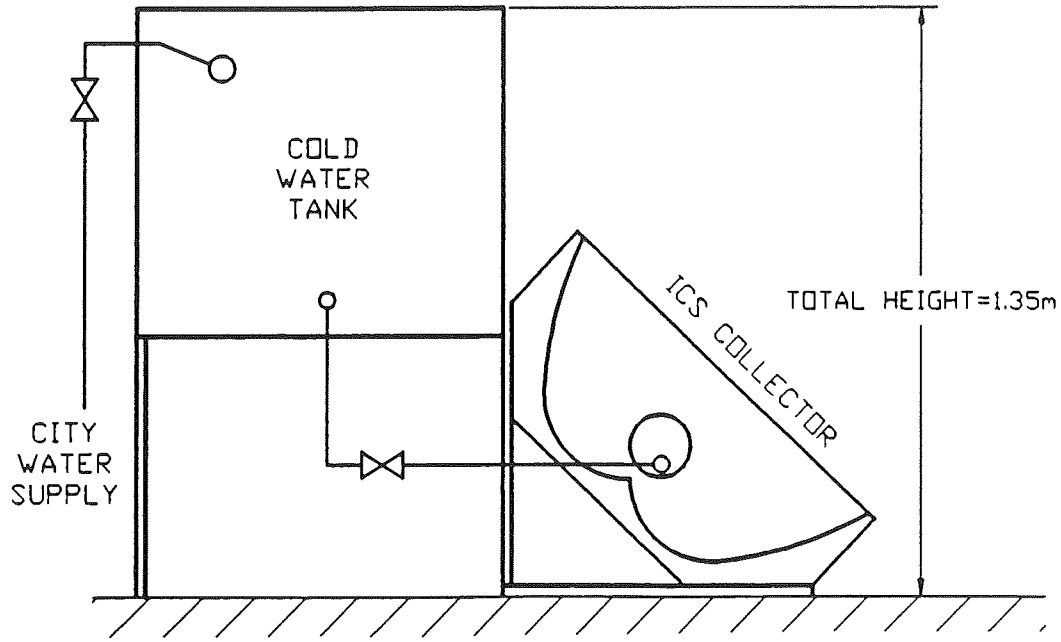

Fig. 6. The complete system

ECONOMICS

A full economic analysis will be carried out after the evaluation of the performance characteristics of the system. A cost comparison will be attempted here to compare the initial cost of the system to that of a flat-plate collector. A cost breakdown of the present system for the 1.77m^2 aperture area is shown in Table 2.

Table 2. Cost breakdown of the ICS panel

ITEM	COST (£)
Cusp concentrator (made from fibreglass at £14/m^2)	45
Reflective material at £8/m^2	25
Hot water cylinder/receiver	30
Sheet metal for back cover	7
Glassing complete with rubber seal	8
Insulation	10
Labour	30
Sub-Total	155
Design, supervision, overheads and profit @ 30% of sub-total	47
Total Cost	202

The cost breakdown for the complete system which includes two ICS panels a cold water tank, framework and valves is shown in Table 3.

Table 3. Cost breakdown of the complete system

ITEM	COST (£)
2-ICS panels	404
Framework	30
Cold water tank	60
Valves and piping and insulation	20
Installation labour cost	30
Total	542

It can be seen from Table 3 that the total cost of a complete ICS system is £542. The corresponding flat-plate collector cost of the same collector area, hot water storage and cold water tank size is £610. Therefore the proposed system exhibits a 13% reduction. The costing however should be investigated over the life of the system for which the performance characteristics of the system are required. This would be the subject of the subsequent investigation. By using simulation data, which compare well with the initial collector performance data, and the F-Chart program (Klein and Beckman, 1981) the present system is analysed economically over a 15 years period. Similar analysis is performed for the flat-plate collector system of the same size. A comparison of the economic parameters obtained from the economic analysis are shown in Table 4.

Table 4. Comparison of economic parameters

System	Yearly F-value	Initial Investment (£)	Life Cycle Savings (£)	Pay-Back Time (Years)
FP	0.83	610	201	11
ICS	0.92	542	409	8

As it can be seen from Table 4 the ICS system is better in all respects than the corresponding flat-plate collector system. If the low profile advantage is also considered, the present system merits serious consideration for future solar energy applications.

In addition to the economic analysis, the program gives the two constant parameters of the standard collector performance equation i.e. optical efficiency = 0.62 and energy loss coefficient = 1.41 W/m^2°C. Therefore the collector performance equation can be written as:

$$\eta = 0.62 - 1.41\frac{\Delta T}{I} \qquad (3)$$

The corresponding equation for the flat-plate collector system used in the analysis is:

$$\eta = 0.77 - 6.78\frac{\Delta T}{I} \qquad (4)$$

This equation applies to a well designed and produced flat-plate collector system manufactured locally. The advantage of the present system, at least during the collection period, can be seen from these equations use the energy loss coefficient for the present system is 1/5 than that of the corresponding flat-plate collector.

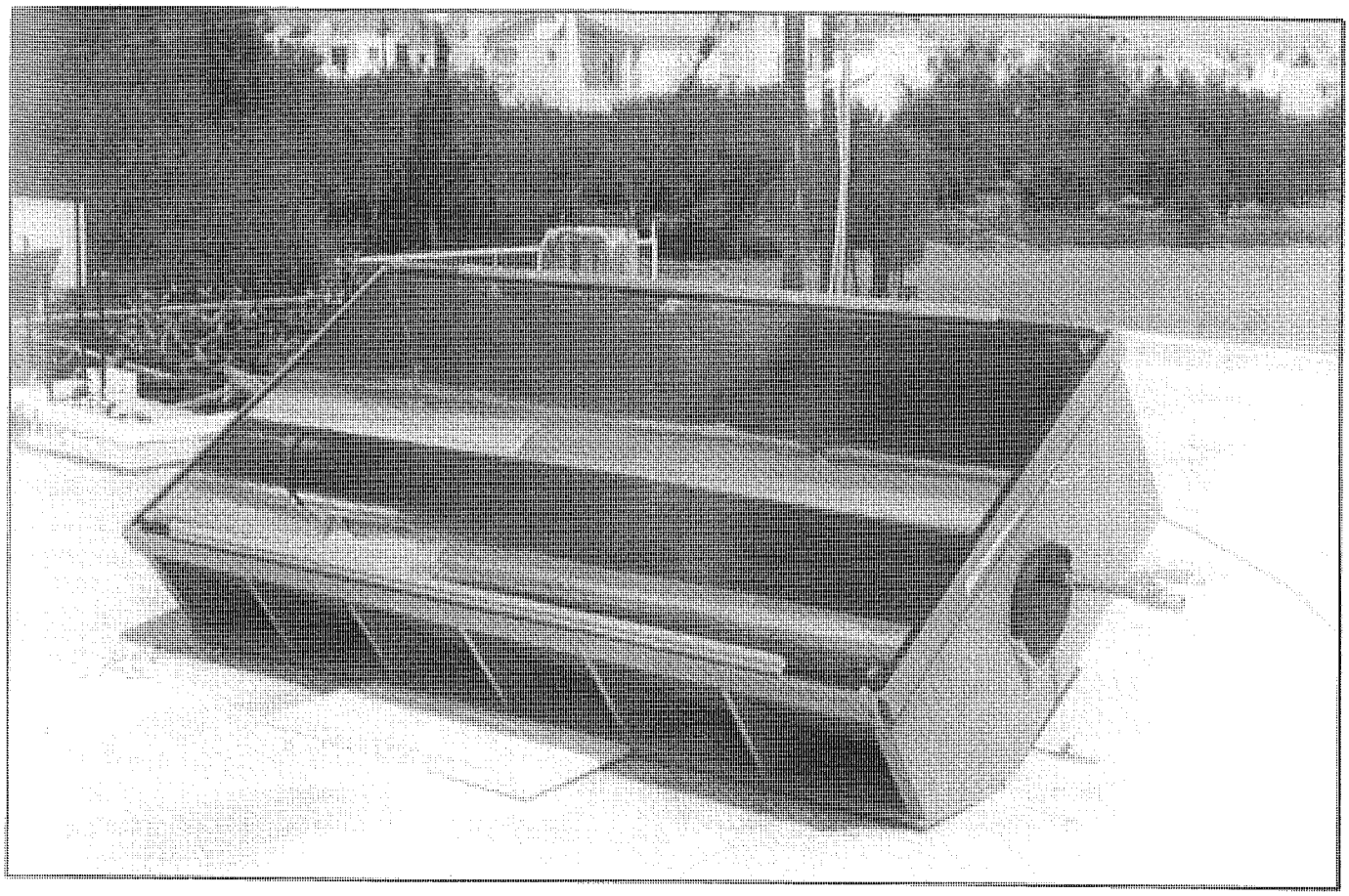

Photo 1. The ICS system constructed and tested

CONCLUSIONS

The design, optimisation, and construction of an ICS collector is presented. This is followed by the economic analysis which gives results in favour to the ICS system when compared to a flat-plate system of the same size. The next objective of the present research is to investigate the performance of the system over a year. In this case potential operating problems would be revealed and more rigid conclusions could be reached on the effectiveness of the system.

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DECISION SUPPORT SYSTEMS AND INTELLIGENT DECISION SUPPORT SYSTEMS

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ABSTRACT

Information Technology has tremendously influenced Cypriot businesses. Computers can be found in almost every office but they are used mainly for running operational level systems. Sophisticated Information Technology (IT) systems may be developed though which are able to provide support also to management, during the decision taking process. The objective of this paper is to stir the interest of the readers and specifically of the Cypriot managers towards such systems. The paper therefore initially presents an overview of the area of managerial decision making , then concentrates on discussing Decision Support systems as well as Intelligent Support systems . At the end, a summary of the related research taking place at HTI is presented.

INFORMATION TECHNOLOGY FOR MANAGERS

Decision making is a complicated intelligent process which involves a lot of human and informational resources. The number of factors to be considered and the scale of information involved make traditional (not automated) decision making extremely difficult. Very often managers have to rely on intuition or God's help rather than on scientific analysis and proper evaluation. There is a great need to improve effectiveness and performance in decision making. For small countries like Cyprus, where the majority of businesses are relatively small with limited resources and strong local and foreign competition, this need becomes more actual. Businesses in Cyprus can become more competitive and suffer less costs from wrong decisions if they integrate IT to the decision making process. Managers must view IT as one of the strongest supporting agents to managerial decisions and must strive to establish IT as a managerial partner.

It is very encouraging to note that Cypriot businesses have embraced IT and are using it extensively for transaction processing operations. The "Final Report on Information Technology Strategy" published by the Cyprus Development Bank in 1993 points out that there is no real information management penetration in Cyprus and that only the transaction processing and operational levels of organisations are computerised widely in Cyprus. However it was made obvious in the study that there is a need for systems that arrange and summarise the circulating information for effective decision making. It is thus of major importance for Cypriot managers to pursue the upgradability and the enrichment of their businesses with systems that relate directly to the problems faced by middle and upper management.

Such systems can be split into three major categories. The first category houses the *Management Information Systems (MIS),* which summarise and present organisational data accumulated or created by in-house transaction processing systems. In addition it includes the Executive Information Systems(EIS) which extract critical and preselected information from the data of the company's MIS systems and present, in a nutshell using graphs and other presentation means, the organisational information as needed by the executives of the organisation. The second category houses the *Decision Support Systems(DSS)* and the *Group Decision Support systems(GDSS)* as well as the *Executive Decision Support systems(EDSS)* which are computer based systems that provide interactive information support to managers or group of managers during the decision making process [2]. These systems do not decide for the managers but assist managers in taking the right decisions by providing the right data during the Decision process. DSS systems give to the decision maker a set of capabilities to apply in a sequence and form that fits each individual's cognitive style [4]. In order to be able to provide decision information a DSS system utilises data (both internal and external), includes an interactive user interface and provides answers based on models designed from beforehand. It is important to note that these systems are quite different from MIS because they process data from the external environment of the organisation (com-

petitors, government, external organisations, etc.) and not only from the internal environment and may be used for repetitive decisions or even for only a specific case. Finally, the third category houses the *Artificial Intelligence Systems both Expert systems(ES)* and other *Artificial Intelligence (AI) systems.* Existing ES do not provide support to management but actually decide in place of the manager and suggest a specific solution to managers based on the knowledge of an expert which is captured and entered into the system from before hand or due to system learning during the system operation time.

Each of the above mentioned types of systems has its own distinct characteristics, benefits and disadvantages and is best suited for specific purposes. Management though, in many different cases, really needs the services of an Intelligent Decision System or a Super DSS which integrates the IS, DSS and ES capabilities together. Only then the manager will feel that he/she really has a decision support partner.

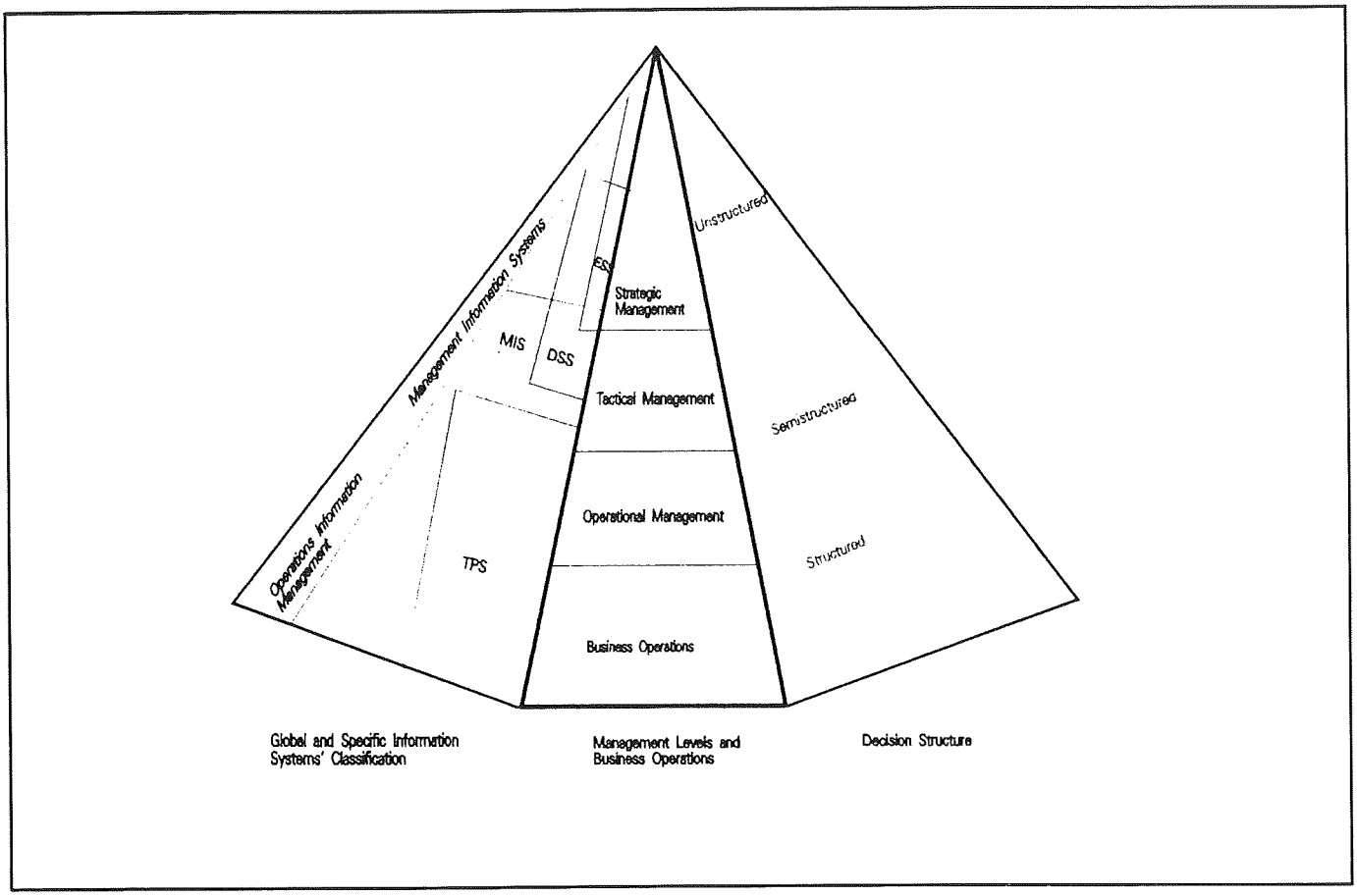

Fig. 1. Relationship of Management to Information Systems and Decision Structure

THE DECISION PROCESS

When taking a decision a manager applies a series of processes on a problem. Simon (1960) described four different phases in the decision taking process: The first one is the *Intelligence* stage where the problems, the reasons and the effects of those problems are identified. The second stage is the *Design* where many different possible solutions are designed. The third stage is the *Choosing* which is actually the selection, from among the various alternatives, based on the results derived by the plans designed in the previous stages. The fourth stage is the *Implementation* where managers follow up the progress of specific decisions [3].

The different types of problems that are expected to be solved are also a significant aspect of decision. Decisions taken relate to problems that range from highly programmed problems to highly unprogrammed problems [1]. Three major problem categories can be identified though. The first one is the *Structured* which is actually a problem which can be solved with repetitive routine type solutions. In this case all the phases of decision taking are structured. The second type is the *Unstructured* where there

are no straight forward solutions; problems are more fussy. The third type of problem is the *Semistructured* where some phases of the decision process are structured and some are unstructured.

DECISION SUPPORT SYSTEMS

Definition

Many different definitions which all lead to the same meaning have been given. Turban [1] says that "A DSS is an interactive, flexible and adaptable Computer Based Information System, specially developed for supporting the solution of a particular management problem for improved decision making."

DS Systems have been in existence since the 1970's and have been used by top management and middle management. Such systems are supportive to the operational level, managerial control level and the strategic planning level of the control hierarchy of an organisation. In addition, decision support systems aim to be supportive at least to some of the stages of the decision taking process. Indeed Decision Support systems proved to be ideal for tackling Semistructured problems, which arise during the Design phase of the decision taking process. In spite of its strength in dealing with semistructured problems, DS systems can provide though significant contribution to all the phases of the decision making process[4].

Classification

DSS may be classified using the following three different classification methods.

a. On the type of problem attempted to be solved; Under this method of classification a DSS can be viewed as *Institutional* because it deals with complex problems that continually face an organisation or as *Ad Hoc* because it attempts to solve less complex problems that may be faced only once by a manager.[2]
b. According to the decision maker using the system; Under this classification a DDS may be classified as *Individual (DSS)* for single user decision making, *Group Decision Support System (GDSS)* for supporting group decision making, and *Organisational Decision Support System (ODSS)* for supporting organisational or community decision making.[3]
c. On the degree of data or modelling used; A DSS can be *Data intensive* or *Model intensive* .To be a true DSS, a system must have both data and model integrated together as integral parts of the system.[3]

Some Existing DSS Systems

Many successful implementations of decision support systems have been reported until now. Some of these systems brought significant returns to the organisations which used them. The following is a sample list of some known DSS: "Egyptian Cabinet" group DSS, "IFPS" financial DSS Generator, "Financial Planner" DSS Generator, Ovacle Express DSS generator, "SPSS" forecasting Modeller, Excel more, "Supertree " DSS decision trees tool, it is important to mention here that many DSS and especially the ones classified as Specific are not available to the public since they have been designed to meet the unique needs of a specific organization.

Indicative Business Domains

Decision Support systems may be developed or used to support a multitude of business decisions. The variety is as big as the number of businesses and the specific type of decisions each manager is expected to make. Some indicative business areas that may utilise effectively such systems are the following: Formulating Corporate Strategy, Product selection, Marketing Management, Investment Decisions, Financial Decisions, Manufacturing control, Human resources utilisation, Banking (e.g. Loans management).

Technology involved

When viewing DSS from a technological point one notices that three different levels of integrated software and hardware have been identified[1,3,4]. These levels are discussed further on.

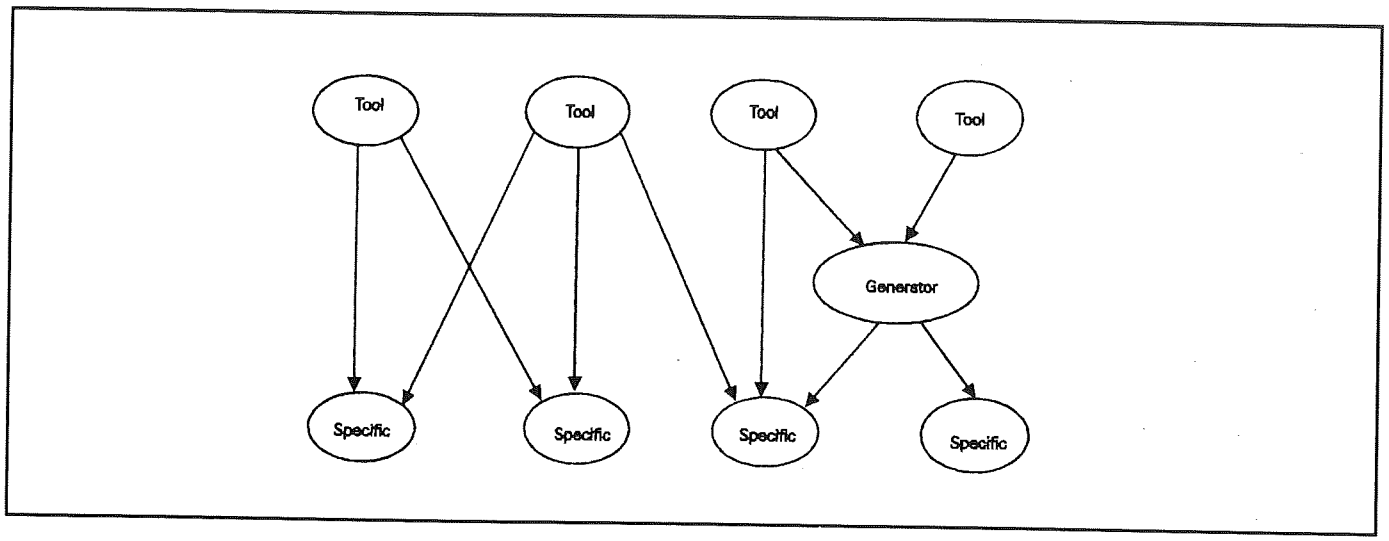

Fig. 2. DSS Technology Interaction

a. **Specific DSS** are the "final Products" or the computerised DSS which actually accomplish the work. They are applications which are significantly different though from the traditional applications. Examples include applications like Portfolio Management System and PoliceBeat allocation system [4]. These systems serve a specific purpose, are usually designed and developed from beforehand and always solve the specific problems they were designed to solve.

b. **DSS Generator** on the other hand are packages that provide the possibility and facilities to quickly and easily build Specific DSS. These packages may include facilities that are already in wide use in stand alone systems but which under a DSS are integrated together into one system which acts on common data under one common language. These facilities may be query modules, report generators, modelling languages etc. Other DSS generators are constructed though around special purpose languages and strong DBMS capabilities [1]. Ideal examples of easy to use microcomputer DSS generators is Lotus 1-2-3 and Excel which are constructed around the spreadsheet technology. The "spreadsheets" as they are usually called are definitely the most widely available DSS generators and if effectively used may prove to be very valuable to a lot of managers. The treasures of spreadsheet DSS generators are still to be uncovered by the Cypriot managers and their modelling capabilities seems to be greatly underestimated and under-utilised even by the computer society of Cyprus.

c. **DSS Tools** are lastly the fundamental software used to generate the Specific DSS or DSS Generators. These involve new special purpose languages, improvements in operating systems and graphics software [1].

Software Components

Designing a Generator or Specific DSS for supporting management involves the use and building of various logically independent and still integrated software components. These software components communicate between them during the support process and are the DBMS, the MBMS and the DGMS [1,4]. Since an effective DSS must encompass all the characteristics of all three components, a detail discussion of every component follows.

a. DBMS - Data Base Management System

The technology regarding Database Management is mature and therefore this component is initially well understood. It must be emphasised though that the required DBMS facilities for DSS extend beyond the standard DBMS facilities.

Two major differences exist between DSS DBMS and standard DBMS. Firstly, the DSS handles data from a set of different data sources, contrary to typical organisational databases which handle mostly data originating from internal sources. The data used by a DSS may originate from *external* sources(i.e. sensors, satellites, cd-roms, films television, pictures, diagrams, government reports), from *internal* sources which are usually the various departments (i.e. people, products, services, processes), from *other internal* sources (i.e. reports, summaries) as well as from the *user* using the DSS at a specific time (personal estimates, opinions of how competitors will react). At the same time data originating from internal data may be non-accounting and non-transactional and may have never been computerised [1, 4]. Secondly, the extraction process requires that it be flexible since additions and changes may be required due to unanticipated queries.

The existing DBMS types may be used once the appropriate data capture procedures are established. The most prominent of all is the relational DBMS which allows flexible retrieval of Ad-hoc queries. Examples of such systems are Oracle, Ingres, Focus, Informix, Sybase, etc.

b. MBMS - Model Base Management System

A Model Base Management System is a system that supports the development, revision, and control of the models in a DSS model base and supports the analytical modelling needed to assist the decision making process [2]. Modelling on the other hand involves the transformation of the real world problem into a prototype structure and it is used by Management Science mainly for solving structured and semi-structured problems. It is thus a simplified representation of reality [1].

There are three *types of models* which are categorised as such based on the level of representation used. The first one is the *Iconic* (scale) model which is a replica of the real system but in small scale; for example a bridge. The second type is the *Analog* where the model behaves like the real system but is not its replica; for example bridge represented by colours. The last type is the *Mathematical or Quantitative model* which represent the real world using mathematical or quantitative methods.

To implement these models any of the following *representation techniques* may be adopted.

- *Complete Enumeration* - small number of alternatives is solved to find the best solution.
- *Optimisation via mathematical programming* - Resources are allocated to optimise the measurable goal. Linear programming, integer linear programming , non linear programming and goal programming may be used.
- *Simulation* - The reality is imitated and a technic is selected which leads to a "good enough" solution. Probabilistic simulation, time dependent, time independent and visual simulation may be exercised.
- *Heuristics* - Ill structured problems may be solved using heuristic programming or expert systems. Symbolic rather than numerical processing is involved.
- *Descriptive models* - Models are formed in the form of rules. It is not a quantitative technique but it can be used in co-operation with a quantitative technique. Solutions are found by obtaining "what if" answers.
- *Financial and planning modelling (Strategic Modelling)* - it has to do with applications that deal with financial analysis or planning. Under this technique the models are algebraically designed and "what if" analysis is performed by changing variable values and observing effects on other variables. Sensitivity analysis can also be performed since it is a case where a variable is continually changed by small increments to see the effect on the other variables. Another type of analysis that could be exercised is goal seeking analysis which sets a target and continually changes variables until that target is succeeded [2]. It is worth pointing out that these methods of analysis could also be implemented by other modelling methods mentioned above.
- *Forecasting(Predictive models)* - Decisions depend on forecasts. Judgement method, counting methods, time-series method and causal methods are used .

Various software tools have been designed which allow modelling using one or a combination of the techniques given above. The significant point to notice though is that there is no comprehensive model base management package currently on the market [1]. This means that there is no generalised model management system similar to data base management systems.

c. DGMS - Dialogue Management System

This DSS component provides the user interface that supports the communication between the user and the system. It is also a very significant component because it is the component that allows the user to communicate interactively his/her analytical needs. There are usually two ways of looking at DGMS. One way is from the users' view and the other way is from the DGM system's view which participate in a cyclical communication process.

The dialogue system involves at least the following three parts.

- The *Action language* which is what the user can do through the interface. It is actually the ability to handle a variety of dialogue styles and the ability to change from one style to another. It involves also the accommodation of a variety of media.
- The *display or presentation language.* This involves the ability to display data in a variety of formats and media.
- The *knowledge base* which has to do with the ability of the system to provide flexible support for the user's knowledge base[4].

Finally it must be noted that there are many different dialogue styles and a good DGMS must provide an interface where different dialogue styles will be available[1,11]. An interface can be constructed using Menu interaction, Command Language interaction, Question and answers, Form interaction, Natural language processing, Object manipulation.

Construction Methodology

The construction methodology followed for building a DSS is critical for its success. Almost all of the Transaction Processing(TPS) and Management Information Systems(MIS) are developed using the traditional "System Development Life Cycle" (SDLC) methodology which has been found to be very successful for systems whose requirements are quite clear since the SDLC methodology has clear distinct phases. In SDLC each of the phases finishes, is reviewed and then the next phase is implemented. Building a DSS though is different from building a TPS or an MIS system. There are three strategies to be selected for developing DSS [3]. The first one is the *Quick-hit* approach where the organisation is scanned for short, low-risk, high-payoff development opportunities. This is a popular strategy because it does not require a central DSS group and users can develop specific DSS as needed. The second strategy that may be followed is the *Staged Development Approach* which attempts to build a series of specific DSS but in a co-ordinated manner that involves the sharing of software from one stage to the other. This implies that a DSS group is formed and that priorities are set. In addition, the DSS development is considered an organisation-wide commitment and requires that a firm has a considerable experience with information technology. The third strategy that may be selected is the *development of a complete DSS.*

Irrespective of which development strategy is selected, the traditional building method (SDLC) cannot apply though for most of the Decision Support Systems. It has been found through research on already developed DSS that the Evolutionary, or Iterative, approach for building systems is more appropriate because it allows for continual changes. Under this methodology the Design, implementation, and the evaluation tend to proceed concurrently and usually an unfinished product is installed which is finalised through a cyclical refinement process. Usually a mini system, or prototype, is developed and then it is refined iteratively over a long trial period with the participation of the user. Firstly a small, stable, simple system is developed. Then the system is refined, expanded and modified in a series of cycles. Lastly, the system is evaluated after each cycle[2]. A stability stage is reached where the documentation and the training takes place but then maintenance may be applied. This iterative methodology implies that a DSS system never really finishes [1,4] but continually grows according to the needs of the user. Such systems, when large in size, take more than a year to reach to a refined stage and others, when small in size, take quite a short time [4].

INTELLIGENT DECISION SUPPORT SYSTEMS

As mentioned in the introductory section of this article intelligent DSS (IDSS) is the most significant cur-

rent development in the field of DSS and is considered the future of DSS. IDSS integrate DSS and Expert systems utilising in this way the human intelligence organisational resources.

Expert systems is an area of the field of Artificial Intelligence. ES started appearing in the 1970s and since the late 1980s many organisations are pursuing their development in many different business areas. Their main purpose is to provide expert advice to users. They are actually computer programmes that incorporate the knowledge of one or more human experts in a narrow problem domain and can solve problems that the experts ordinarily solve [12]

When comparing DSS with ES similarities and major differences are identified. Refer to the comparative table 1 for a more detail analysis.

Table 1. Comparison of DSS with ES

	DSS	ES
Mission	Support Decision Maker	Capture, Transfer and make available expertise; Make decision and replace user
Domain	Semistructured repetitive or ad hoc broad problems	Problem domain dependent; Unstructured problems; Narrow domain problems
Emphasis	On flexibility and adaptability to user	On justification of action
Decision made by	The user (manager)	The software system
Types of users	Individual or Group users	Individual users
Feedback to users	Satisfactory or optimal solution	Alternative expert solutions; Reasoning Path
Problem Types	Aids user in Solving usually semistructured problems	Solves unstructured or semistructed problems
Problem size	Complex, Integrated, Wide	Narrow domain
Knowledge	Complete; Deterministic facts	Could be fuzzy; Uncertain; Incomplete facts
Date Base	Factual knowledge	Procedural and factual
Processing	Numerical mainly; Quantitative; What if Analysis	Symbolic processing; Qualitative processing
Models	Provides standard models and computations	May provide judgmental elements to model
Dialoque	Must possess an interactive query facility with English like dialoque	Possesses an interactive query facility with English like dialogue
Development	Adaptive (iterative) design process	Problem definition; Knowledge extraction/ formalisation; Prototyping; Fielding
Development	Third and fourth-generation languages	Fifth-generation languages and ES shells
Learning Capabilities	None	Potentially promissing

Sources: El-Najdawi & Anthony C. Styllianou [12], Turban, Sprague [1,4]

During the last decade, proposals have appeared suggesting the integration of the DSS and ES. Various products have appeared in the market or are being used by organisations which actually demonstrate some form of integration. ES and DSS may integrate in the following ways;

a. Expert systems are attached to individual DSS components.

b. An expert system is integrated as a separate DSS component.

c. An ES complements the DSS in one or more of the steps during the decision making process.

d. An expert system is used in addition to DSS to suggest alternative courses of action; something the DSS is not doing.

e. Integrate the DSS and ES in a unified architecture where the ES can be placed between the Data and the models.

Although integration is necessary and major benefits will be realised with the practical implementation of IDSS systems, integration is at this time of age possible but difficult. Educated users are needed, new ways of interfaces must be implemented, involved software must be made compatible , skilled programmers must be used and time and cost for developing such systems must be justified.

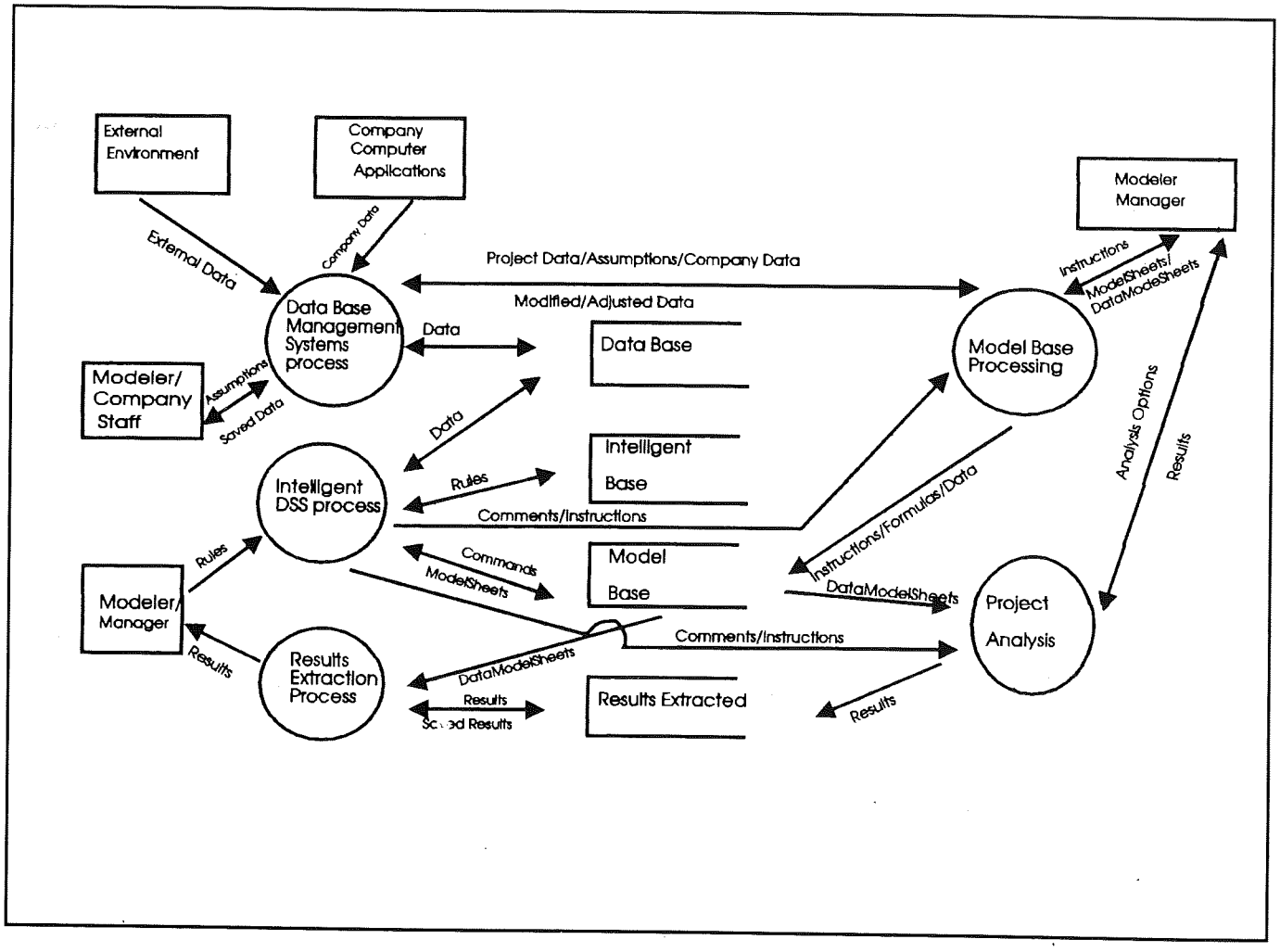

Fig.3 Integrated DSS and ES - An alternative integration method (Expert System participates fully in the Decision Support Process and communicates directly or indirectly with DSS components)

CONCLUSIONS

Cyprus needs to upgrade its Information Technology from transaction processing to decision support and it must start now. Managers must become more demanding. Knowing their needs they must seek and promote the use of systems that will support them during the decision taking process. At the same time, system developers must proceed to develop and or install such systems that will meet the needs of the Cyprus industry in order to educate managers and to help them understand how IT can really support them . The use of DSS and IDSS will upgrade the quality of managerial decisions for the economic benefit of their organisations and of Cyprus. At the same time a new product market for the Information Technology Industry of Cyprus will open up. The technology level available allows the development of effective DSS systems as well as the development of specific IDSS. The process may be difficult , costly, and dedication demanding but the outcome will be rewarding.

RESEARCH AT HTI

Research undergoing at HTI in the area of DSS and IDSS started during the Academic Year 1995/1996. Presently an integrated Intelligent decision support system for the evaluation of simple investment decisions has been designed. Sample models have been created using Excel spreadsheet and the development of an Intelligent prototype is pursued. At the same time an investigation of the Cyprus market is undergoing. The main objectives of this survey is the discovery of the extend of the use of DSS and IDSS in Cyprus as well as the identification of the most significant areas where computer decision support is needed by the Cypriot managers.

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LESSONS LEARNED FROM THE 1995 PAPHOS EARTHQUAKE IN CYPRUS

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INTRODUCTION

On the 23rd of February 1995 Cyprus was hit by an earthquake of magnitude 5.2 on the Richter scale (local magnitude). The tragic outcome of this earthquake was two dead, many homeless and material damages which were estimated to about six million dollars. The last catastrophic earthquake that hit Cyprus was in 1953. Since then there were some earthquakes of smaller magnitudes that did not cause any damages. The purpose of this paper is twofold. First, the post-earthquake response of the Civil Defense, the mass media and the engineering society is evaluated, in an effort to identify any shortcomings which should be corrected before the next earthquake. Second, an effort is made to analyze the behavior of buildings through the damages they suffered during the earthquake. For this purpose the buildings are classified in three categories: non-engineered stone-build houses, churches and reinforced concrete buildings. Of particular interest is the behavior of the reinforced concrete buildings that were built after the introduction of the Cyprus Seismic Code in 1991. Finally conclusions are drawn about the behavior of the buildings and the causes of their failures.

EARTHQUAKE ACTION PLANS

In the same way as with any other catastrophy, after an earthquake there should be an action plan which will be used to face the various emergency needs that will emerge. In the case of an earthquake the problems are multiplied due to the total destruction of the lifelines. Some of these lifelines are the electricity, telecommunications, water supply and highway networks. In addition, an earthquake causes panic to the people who stay for a long time away from their homes, due to the fear of a new strike by an earthquake, and therefore there should be the necessary infrastructure for calming them down and providing them with shelters and food.

The recent Paphos earthquake gave the Cypriot authorities the chance to check their readiness in facing the results of an earthquake. The earthquake, as it is usually the case, came without warning and it found us unprepared to face its consequences for the reasons that I will mention below.

Mass Media

Right after the earthquake, the people turned to the mass media to get information regarding the extend of the catastrophy and to learn what they should do in the following hours. I believe that most of the media instead of giving these valuable pieces of information they tried to use the event to boost their ratings and in some cases they created panic instead of calming down the people. In one instance the inhabitants of some villages were urged to abandon their houses because there were problems in a nearby dam, which was not true. In another case it was announced that a hospital was filling up with injured people, which again was not true. In a third case the news-anchor of a station was insisting to announce the names of the dead couple although the chief of the police who was on the telephone was saying that the names should not be announced until the relatives of the victims were notified.

Under such circumstances, the mass media should have some clear instructions about how one should act after an earthquake, which they should be announcing to the people at regular intervals. These instructions should be outlined in an action plan which should include the mass media.

Civil Defense

The Civil Defense is a governmental organization which has the duty to provide help to civilians during the course of a catastrophy. Unfortunately, they tread the earthquake as being similar to any other catastrophy and they do not have a specialized earthquake plan. In the case of the Paphos earthquake the Civil Defense acted immediately and provided shelter to the people of the Arodes village which was the most seriously affected village. But the shelter is not the only need that somebody has right after an earthquake. I would say that shelter is the last thing that these people need. The main concern should be first to move to the disaster area specially trained rescue units who will look for survivors under the ruins. From what I know the Civil Defense does not have such units. And we were very lucky that the magnitude of the earthquake was small and we did not have trapped people under the ruins in various parts of the country. The only people trapped were the two elderly people in the village Miliou who were unfortunately retrieved dead from the ruins. Their rescue was rather difficult because of the lack of specialized equipment and machinery. Therefore, we need specially trained rescue units which should be able to undertake the rescue of people from the ruins, and also an earthquake disaster action plan.

Civil Engineers

The other group of people who should be present in the disaster area are the Civil Engineers. The specially trained groups of engineers should be able to classify the buildings in categories according to the danger of collapse. After a building is classified as dangerous, the entry in that building should be prohibited by using signs and if necessary barbed wire. In the case of the Paphos earthquake it took the engineers of the Public Works Department one day to arrive in the area and classify the buildings, and they spent their time only in one village. The classification was based on an approximate estimate of the cost of repair of the buildings, which was showing in an indirect way the danger of collapse for each building. The rest of the district was covered by the District Authorities. Therefore, for a whole day after the earthquake, which is the most critical because of the after-shocks, the people of the Paphos District were moving around their damaged buildings without any restrictions. Signs were placed on the dangerous buildings and the entry in these buildings was prohibited one week later, and their temporary support was done two weeks after the earthquake. Hence, we can conclude that we failed also to provide the necessary protection to the people affected by the earthquake immediately after the event. The reason for this is again the lack of an action plan which provides for the presence of specially trained engineers to perform the tasks mentioned above.

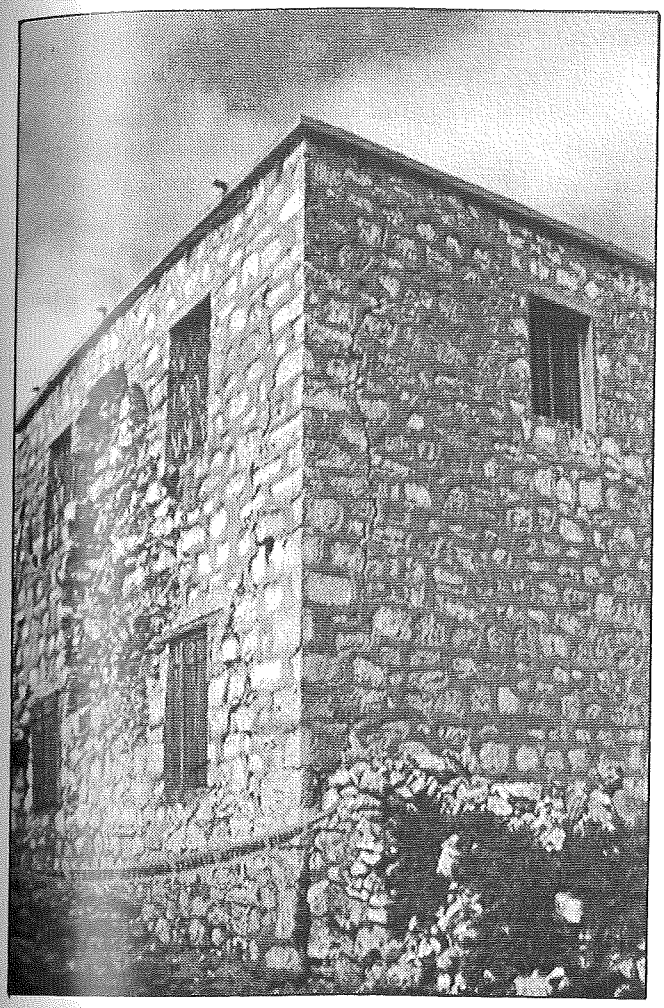
The District Authorities

The District Authorities, which undertook the coordination of the operation in the area, had a very difficult task since they did not have an earthquake action plan by which to coordinate the various groups working in the area. They had to provide temporary shelters and food to the affected people, to estimate the damages of the buildings, to support the dangerous ones and prohibit the entrance to the owners, to demolish the buildings which were posing a threat to the people e.t.c.. Due to the enormous effort of all the people, who were working around the clock, they managed to succeed in their difficult task. Their work would of course be much easier if they had an existing earthquake plan which would dictate how each group would work to accomplish the recovery from a devastating event such as an earthquake.

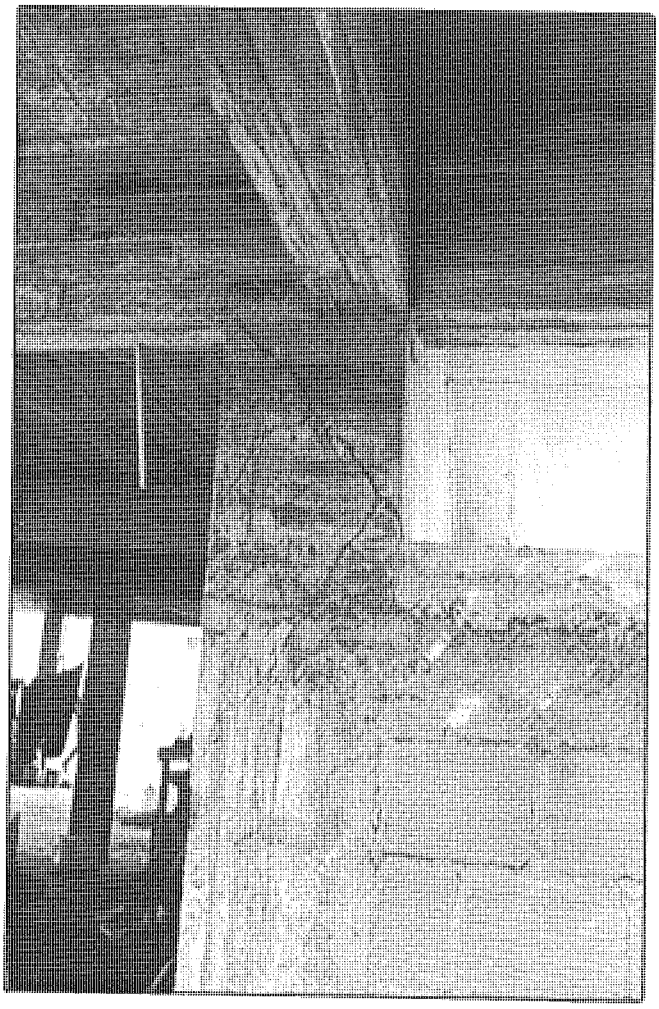
I believe that we should be thankful that the Paphos Earthquake was not so catastrophic to demand a very well organized earthquake action plan to deal with its consequences, otherwise we would have had many problems. Our experiences from this earthquake show us that we are not prepared to face the results of a catastrophic earthquake and therefore we need to prepare an earthquake action plan which will be dealing with the aftermath of an earthquake.

BEHAVIOR OF THE BUILDINGS

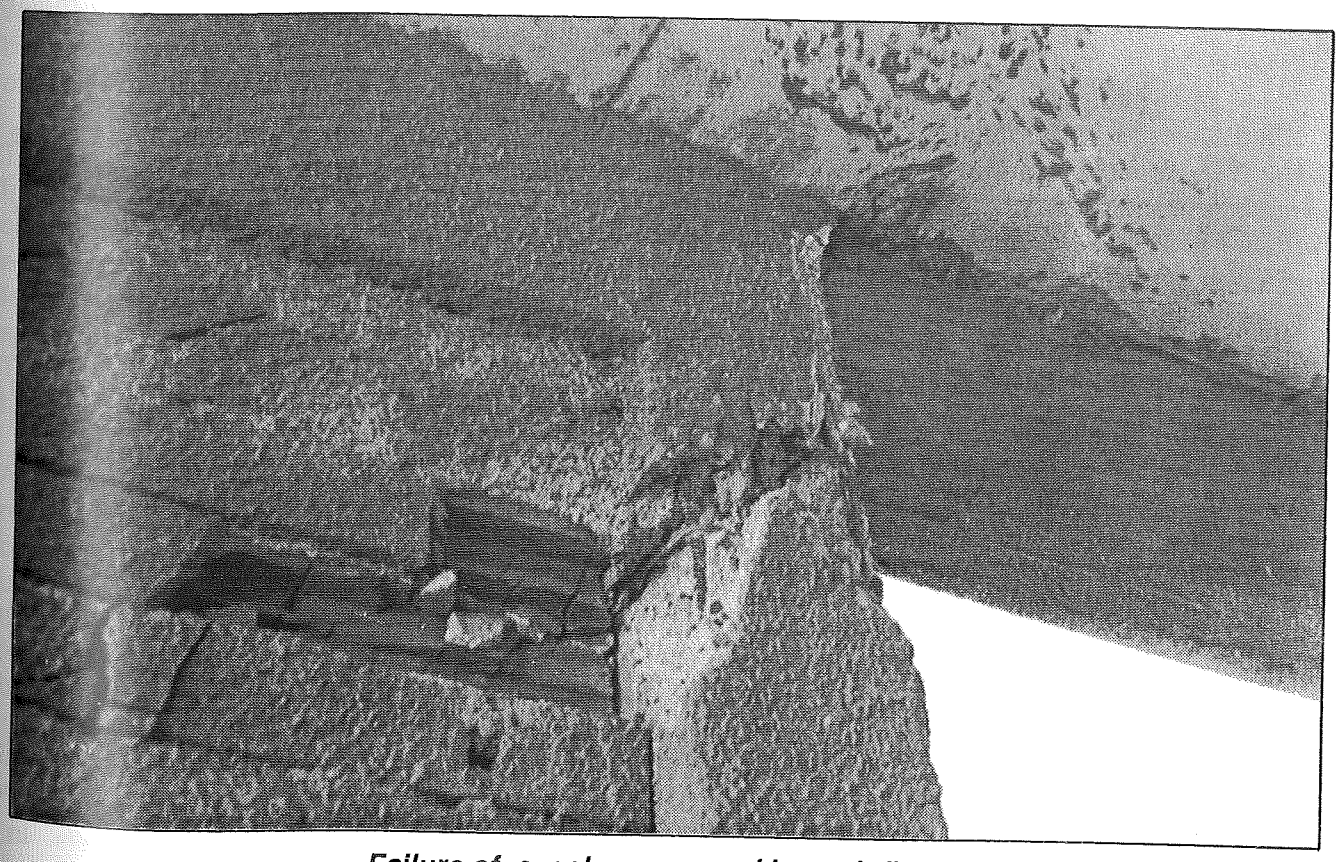
Although the Paphos earthquake was not catastrophic it caused damages to many buildings in the Paphos District. The effects of the earthquake appeared also on buildings in other parts of Cyprus in the



Failure of an exterior wall of a two storey house



Failure of a short column



Failure of a column caused by an infill wall

form of minor cracks. The structures that suffered damages may be classified in three categories:

1. non-engineered stone-build houses
2. churches, and
3. reinforced concrete buildings.

Each one of these categories showed some characteristic behavior which will be presented below through some representative examples.

Non-Engineered Stone-Build Houses

Most of the buildings in the Pano-Arodes village were stone-build and the stones were connected with mud. In some cases there was mortar lining on the outside and gypsum on the inside. In most of the cases the walls consisted by two leaves with no connection between them. The roofs were of three types: wooden joists covered with canes and mud, wooden joists covered with lightly reinforced concrete, or reinforced concrete.

The buildings affected by the earthquake were mostly two-storey. A failure that characterized the two-storey buildings was the collapse of the outer leaf of the wall of the second-storey. This was primarily due to the fact that there was no connection between the inner and outer leaves of the wall.

Another characteristic of the failures was the vertical cracking of the two-storey buildings at the corners where the stones were intercrossed. This crossing was causing strengthening of the corners of the building which was responding in a different way than the rest of the building and therefore we had the appearance of the vertical crack.

Buildings which had good stone lining suffered less damage. In many cases, especially at Arodes, there was mortar lining in part of the structure. It was observed that these walls suffered considerably less damage than the others that had no lining. The reason for this is of course that the mortar lining was providing shear resistance to the wall and was preventing the formation of cracks. On walls that there was no lining, crack widths of up to 15 cm were observed.

Another characteristic that was observed was that most of the damages were suffered by the walls which were not supporting the roof joists. In many cases such walls showed large displacements and wide cracks.

The total collapse of walls of the two-storey houses depended on both the location and the shape of the buildings. The second-storey walls of two-storey houses neighboring single-storey houses collapsed. This was due to the restraint that was provided by the single-storey house at the level of the second floor of the two-storey house, which had as a result the concentration of large shears at that level which caused the collapse of the walls. This occurred in at least three case at Arodes.

The irregular shape was also one of the reasons that caused collapse of walls. Both the building that caused the death of the elderly couple and the neighboring building had an L-shaped first-storey and a rectangular second-storey. The irregular shape may have caused a torsional vibration which resulted in the collapse of the second-storey wall. In the case of the victim's building we had a total collapse of the wall and consequently, the collapse of the slab caused the death of the two people. Fortunately, in the neighboring building only the corner of the two walls collapsed and we didn't have any additional victims.

All the single-storey buildings that suffered damages had the common characteristic that they had an arch in the middle of the building. These arches suffered damages and also they caused damages to the transverse walls.

Churches

Many churches suffered damages from the earthquake. The damages were observed mainly on the roofs and the bell-towers of the churches, although in some cases cracks appeared on the side walls. In

the Arodes church, the bell-tower, the roof and the side-walls suffered considerable damages. The bell-tower broke in two pieces and the top part moved about 15 cm relative to the bottom one. Internally, there were longitudinal cracks on the roof-shell due to the transverse vibration of the building. Remarkable damages were also suffered by the churches of Peristerona (at the roof and the side-walls), Kathikas (some cracks on the bell-tower), Kinousa (the bell-tower suffered considerable damage and was demolished, and cracks appeared at the roof and the arches), and Lysos (the bell-tower was demolished and cracks appeared on the arches and the roof in particular in the area where the bell-tower was supported).

Reinforced Concrete Buildings

The reinforced concrete buildings that suffered damages can be classified in three categories: schools, houses and hotels. Each one of the categories had its own characteristics which are going to be analyzed below. In general, the new buildings did not suffer many damages. This of course may be due to the fact that the magnitude of the earthquake was relatively small. We may say that most of these buildings suffered aesthetic damages, that is cracking of the infill walls, or separation of the infills from the beams and/or the columns. There were though some cases in which the failures were observed on the structural part of the building.

Schools

The school buildings, due to their use, are required to have many windows so that there is ample light in the classrooms. This makes the schools very flexible buildings. In addition, the skylights create short columns which may fail in shear in the case when they are subjected to horizontal loads. The damages that were observed in the schools of the area were primarily due to the above reasons, and in some cases due to bad workmanship.

The Technical School of Polis-Chrysochous, which was built in the 1960's, suffered damages in the infill walls and the window-glasses. It looks like the two-storey building went through large displacements which caused the breaking of the glasses and the cracking of the walls. From the cracks on the walls, which were only along one of the diagonals, it seems that the building moved only in one direction, in other words it did not vibrate. All the damage on the walls concentrated on the ground-floor and there were no damages on the second floor. Some cracks were visible in the short columns of the skylights but the magnitude of the earthquake and its duration was not large enough to cause further propagation of these cracks.

The Gymnasium of Polis-Chrysochous is also a two-storey building and it is located at a small distance from the Technical School. In the case of this building most of the energy of the earthquake was absorbed by three infill walls, two external that extended up to half the story-height and one internal which extended the full storey-height and was supported by two transverse partitions. The internal infill suffered cracks along both diagonals and caused small deflection to the transverse partitions which acted as supports to the infill. In the rest of the building both the infills and the columns suffered no damages. This is an example where the infills had a very positive contribution to the behavior of the structure and have carried, if not all, for sure most of the earthquake load.

Another school that suffered damages was that of Agia Marina which was also build in the 1960's. It is a reinforced concrete structure with stone infills lined with mortar. In this case cracks appeared in the short columns of the skylights. The strange thing though was that the cracks started from the 3/4 of the column height and were moving towards the top of the column. After we chipped-off the concrete of one of the columns we realized that this was due to the fact that at that point there was overlapping of the reinforcement and there were no links. Therefore, this failure was due to bad workmanship which was brought to the surface by the earthquake. This was the only failure on the building.

Cracks on the short columns appeared also on the skylight short-columns of the school of Kato-Pyrgos which is also a two-storey building and was built in the 1970's. In this case the cracks were very small

and started from the wall and propagated diagonally towards the beam. Glasses also broke and there was separation of the infills from the columns and the beams. No damages were observed at the second floor of the school.

Houses

Of particular interest is the behavior of the reinforced concrete buildings that were built after the introduction of the Seismic Design Guidelines and the Cyprus Seismic Code. The houses that were affected by the earthquake had the common characteristics that they were two-storey the first of which was a soft-storey (pilotis). There were four such cases which will be examined below.

The first building is at Neo-Chorio and it was built in 1992. It consists of a soft-storey, a second storey which covers all of the plan area and a third-story which covers part of the plan area. The infill walls of this building suffered considerable damages both internally and externally. Cracks also appeared in internal beams and arches. It is worth noting that nearby buildings suffered no damage at all. Some of the reasons that this building suffered all of these damages are: a) the multi-level foundations, b) the presence of a soft-storey, c) the presence of a very stiff stair-well on the west side of the building and the simultaneous absence of stiff walls to counter-balance the stiffness of the stair-well, and d) the irregular shape of the building.

The second building is at the village Argaka and it was built in the 1990's. It is a two-storey building with a soft-storey at the ground-floor. It has two stairs in the middle of its east and west sides and reinforced concrete walls (1.20 x 0.20) in the middle of its north and south sides which are oriented in the east-west direction. It also has two similar walls in the interior which are oriented in the north-south direction. Another characteristic is that it has an infill wall at the north side next to the stair and in the same direction as that of the reinforced concrete wall. In this case the wall at the south side of the building failed in shear and a large diagonal crack appeared on both the inside and outside of the wall. The wall at the north side showed no signs of cracking. This could be attributed to the presence of the infill wall on the north frame, which absorbed the earthquake force and in doing so it caused the shear failure of the column of the bounding frame. Therefore, in this case we have an infill wall which due to its isolated presence caused failure to the frame.

The third case is a building at the village Agia Marina which was built in 1993. This is also a two-storey building, with a ground floor which has only the external walls built. These walls were built at a later stage and they are not plastered. The large stiffness of the stair-well which is located at the corner between the north and east sides of the building is counter balanced by three reinforced concrete walls which are located in the interior of the building. The only remark that can be made about these walls is that it would be better if they were located at the perimeter of the building. Two columns of the south frame of the building failed. For both of them the failure was due to the absence of links in the beam-column joint. In addition, the corner column deflected horizontally due to the fact that the reinforcement of the beams was not anchored into the joint. A diagonal crack appeared in the infill-wall in the middle span of the south frame which assisted in the failure of the bounding column. No cracks appeared in the rest of the infills except in those of the stair-well where cracks appeared along both diagonals of the infills. In the second storey there were only aesthetic damages. The infill walls have separated from the beams but remained connected to the columns. An L-shaped bar which was at a corner of a building moved by 23 cm one side and 17 cm on the other side. In addition, all the heat-storage units fell down, irrespectively from their orientation, which shows that the building has gone through large displacements.

The last building that showed some damage was that at Kato-Pyrgos which was built in 1987. It is a two-storey building with a soft-storey at ground floor. It was the first case in which a short column failure was observed. Cracks appeared in both directions of the column. This short column was formed by the floor of the second-storey and the roof of a storage-room which was built in the front of the building. This was the only short column in the building and of course it failed.

Hotels

Damages were observed in the infill-walls of at least one hotel in Paphos. There were considerable movements in the expansion joints and separation of the infills from the beams. It is worth noting that the nearby hotels have showed no damages. This can be attributed to the irregular shape of the hotel and probably the soil conditions.

CONCLUSIONS

The experiences from the earthquake show that there is a need for an earthquake action plan which will provide the necessary guidelines for facing the many problems which arise after such a catastrophy. The response of the buildings to the earthquake is summarized below and some conclusions are drawn about their behavior. The conclusions are divided in the categories: stone-build houses, churches and reinforced concrete buildings.

Stone-Build Houses

1. The two-storey buildings were mainly affected
2. Most of the walls had two leaves with no connection between them. This had as a result the collapse of the outer leaf.
3. The stones that were used to build the walls were, in most cases, of irregular shape.
4. The bad lining had as a result the failure of the walls.
5. The unconnected lightly reinforced slabs did not act as diaphragms and assisted in the collapse of the walls.
6. The inadequate connection of the floor of the second-storey with the walls caused damages to the walls.
7. The arches in the single-storey houses suffered damages and caused movement or even collapse to the transverse walls.
8. The wooden joists prevented the failure of the supporting walls.
9. The crossing of the stones at the corners of the buildings caused vertical cracks around the corners
10. The construction of single-storey buildings right next to two-storey buildings caused the collapse of the walls of the two-storey buildings.
11. The irregular shape of the buildings caused collapse of the walls.

Churches

1. As expected, the bell-towers of the churches were affected.
2. Considerable cracks appeared at the arches of the churches.
3. Cracks appeared at the shell roofs of the churches.

Reinforced Concrete Buildings

1. Damages were suffered mainly by two-storey houses which had a soft first-storey.
2. The irregular shape of at least one building was the main reason for the cause of damages.
3. Buildings that had bad detailing at the joints suffered damages (lack of links in the beam-column joint).
4. Drainage pipes located in the columns assisted in their failure.
5. The infill walls in most cases assisted in the resistance of the earthquake load. In some cases they caused damages to the structure due to their improper location.
6. In the case of the schools which are two-storey buildings without a soft-storey, the infill walls limited the damages to the first-storey.
7. Collisions of buildings at the expansion joints were observed.
8. Cracks appeared in short columns, and there was at least one short column failure.
9. Failure of at least one reinforced concrete wall was observed.
10. Separation of infill-walls from the structural members were observed which causes aesthetic problems.

THE PARTICIPATION OF CYPRIOT WOMEN IN PUBLIC LIFE

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ABSTRACT

Despite the fact that women fought hard to win equal political rights with men, their participation in public life worldwide has been very low. Very few women stand for election and as a rule very few get elected. In Cyprus, in the recent elections of 1996 only 3 women were elected in the House of the Parliament. The aim of this article is to present a picture of Cypriot women's participation in Public Life and to investigate the reasons of their low participation.

INTRODUCTION

In traditional Cypriot society there were different roles for men and women. The man was involved with community and professional activities -as protector and supporter of his family, while the woman's role was primarily in the house -doing the housework, raising her children and serving her husband. Public and political life was a male domain and women played a secondary role.

The dramatic political and socio-economic changes after the independence of Cyprus, as well as the effects of the Turkish invasion brought about a change in the social values and expectations regarding male and female roles. The economic developments, the improvements in the system of Education and the achievements of women abroad contributed to the evolution of the position of Cypriot women in the family and the society.

In contemporary Cypriot society, more democratic principles prevail in the family whilst there has been an increase in the involvement of women in education and the labour force. Despite changes, women are mainly employed in low paid occupations, such as clerical and sales, whilst their participation in high status occupations and posts of authority in the public and private sector is very poor. Public life is a male area where women's participation is negligible.

WOMEN'S PARTICIPATION IN CYPRUS PUBLIC LIFE

According to relevant research studies women's participation in public life can be considered to cover the following areas:

1. Women's participation in the liberation movements of the people.
2. Women's participation in community activities.
3. Women's participation in Decision Making centres.

1. Women's participation in the liberation movements of the people.

Contrary to their gender role expectations women play a significant role during wartime. Though there are many cases where women fought bravely in the front line alongside men, history books, which are mostly written by men often neglect the actual contribution of women.

In Cyprus women contributed in several ways to the struggles of Cypriot people for freedom throughout its turbulent history. They participated in many activities during the liberation struggle of 1955-59 against British occupation. Some typical examples are transportation of weapons and supplies, spying, providing refuge for freedom fighters and many others. After wartime women who lost their husbands had to undertake enormous family obligations and responsibilities.

This role became particularly dominant after the Turkish invasion and the consequential calamities that had fallen upon the people of Cyprus. The termination of the Turkish occupation and the unification of Cyprus is of predominant importance to Cypriot women, who have proved it on numerous occasions. They organised marches and formed a human chain along the dividing line, while in all women's and other international fora that they have participated they demonstrated their protest against the occupation and the division of their country.

2. Women's participation in community activities

Women's contribution in voluntary organisations, is an activity closely linked with their female gender role socialisation -of giving and caring about others. Until the last century this was the major domain of women's participation in public life, especially of middle and upper class women. These organisations cover various fields such as family and child guidance, assistance to the aged, people with special needs, environmental issues and consumers' rights.

In Cyprus most charity organisations are subscribed to and run by women. It is worth mentioning the activities of women in the Cyprus Red Cross, staffed mainly by women, which contribute to the welfare of people in need in times of war and peace.

3. Women's participation in Decision Making Centres

Referring to Macciochi's study on *The Position of Women in Decision Making Centres,* in Europe, Cypriot women's participation in the following centres is assumed to be representative of their overall participation:

a. Government elected and appointed posts.
b. The leadership of Political Parties and Trade Unions.
c. Means of Communications.

a. Government elected and appointed posts

In the turbulent history of Cyprus, where various conquerors, successively occupied the island, men and women were given political rights by the Constitution of the Republic in 1960. Legally, men and women in Cyprus enjoy more or less equal political rights.

Women's participation in the relatively short political life of Cyprus has been very poor. There were only two women who were appointed to positions of authority in the Republic. Ms Stella Soulioti who served as Minister of Justice (1960-1970) and then Attorney - General of the Republic (1984-1988) and Ms Claire Angelidou who since 1993 has been the Minister of Education and Culture.

In 1980, Ms Rina Katselli became the first woman to be elected in the House of Representatives. In the elections of 1991 the number of women elected increased to three, while three women were elected in the recent elections of 1996, comprising 5% of the elected posts. This is a poor response considering that the number of women candidates who stood for election has increased from 16 in 1985 to 56 in 1996.

Women's participation in other Decision Making Centres in the Public and Private establishments is negligible. According to the Statistics, in 1992, women hold only 4 out of 132 posts in the Government at highest levels. Another area where Cypriot women show a willingness to participate is Local Government. Women constitute about 15 per cent of the elected Councillor posts whilst there are two women mayors. In addition three women were elected by the members of the Municipal Councils as vice-mayors.

b. The leadership of Political Parties and Trade Unions

There is no woman in the leadership of any political party or trade union, while their representation in the decision making centres is negligible. Trade unions are usually affiliated to political parties and women's role within the Unions has little influence. Whilst all Unions have sections dealing with women's matters, policy making in the section is directed by men.

In Cyprus women's organisations are mainly affiliated to the political parties and the Trade Unions. In the labour history of Cyprus, women never went on strike in pursuit of their specific rights as women. However, there is evidence (as seen in Figure 1) that women fought alongside men, demanding basic labour rights, such as Social Insurance, increase of wages and shorter working hours.

In 1988, the Government of Cyprus set up the Permanent Central Agency for Women's Rights, (in 1994 it was reformed with the name National Machinery for Women's Rights) which is the only body dealing with women's matters and has advisory role. It consists of a core service at the Ministry of Justice and Public Order and a network of boards composed of representatives of government departments, women's organisations and trade unions. It must be noted that the Cyprus government with the contribution of women's organisations has ratified most of the U.N (United Nations), I.L.O. (International Labour Office) and other conventions for women's rights.

A delegation of the Women's Branch of the Pancyprian Labour Union, on their way to deliver a resolution to the Court, demanding legislation for Social Insurance

c. Means of Communications.

The Communication media nowadays are very powerful in shaping views and attitudes. Their role is very influential and seems to do a great deal towards crystallizing social values and reinforcing the traditional role of men and women. There was only one woman promoted as head of a department in the National Broadcasting corporation, though women constituted 40% of the permanently employed personnel. Though more women are employed by the private broadcasting corporations, operating after 1990, they possess no positions of authority. In addition, in Cyprus press there are very few women political editors, while there was only one woman chief editor of an evening daily newspaper.

The low participation of women in Public Life is a worldwide phenomenon. In Europe, there are differences in women's participation in Decision Making Centres, with Sweden in the leading position with 50% participation of women. In the European Union women's average participation in their Ethnic Parliaments is about 15%, while they constitute 20% of the European Parliament seats. Several research studies have been undertaken in Europe and other countries aiming to investigate the reasons of this phenomenon.

FACTORS AFFECTING WOMEN'S PARTICIPATION IN PUBLIC LIFE

A research study conducted in Europe indicated that politicians have generally high status occupations with a high level of education, above the average. Since women usually follow less prestigious occupations, they are at a disadvantage compared to men.

Another research revealed that women's involvement in professional activities limits their participation in the management of public affairs over and above their family responsibilities. As working women with a family undertake most of the family obligations, (doing housework and raising of children) it is difficult for them to go into politics.

Furthermore, the fact that politics is a male arena with male values increases the difficulties faced by women. Political campaigns are characterised by hard competition and bitter fights; behaviours which are strange to female nature. Women are new in this domain and they don't have role models, while the ones who have excelled in politics usually imitate men's behaviour.

In Cyprus, traditional Patriarchal attitudes, still prevail and the political views of a large number of Cypriot women are influenced and directed by men. Cypriot women generally lack political awareness and they are not concerned with politics or women's issues. A research study conducted by Kalava (1982: 101-113) on women's attitudes to politics found that women were in a transitional stage towards crystallising their own political views; only women with higher education were informed and involved with politics.

In addition, women are faced with a negative attitude by men as well as by women voters and as a consequence they need to prove themselves. There is a lack of confidence by women voters to women candidates. This is a sociological phenomenon which is valid not only to politics but also to other areas; for example women in traditionally male occupations such as doctors, lawyers and engineers.

In the elections of 1996, only 3 women were elected, constituting 5% of the parliament seats, while women candidates comprised 14% of the total number of candidates. This indicates that women voters who represent more than 50% of the voters, do not vote women candidates. Although all the political parties in their campaigns strongly support women's rights, they do not actively promote women.

In Sweden and in other countries where the Political Parties have introduced the "Quota system" the number of women in politics has increased considerably. The "Quota system", is a temporary measure aiming to promote women's involvement in politics. It specifies by regulation, a minimum percentage of posts of authority in the structure of a political party, which should be reserved for women. In the Labour party of the U.K the agreed "Quota" is 40%, while in the Socialist party of Sweden it is 50%. There is a big debate around this system. The ones in favour support that this measure is necessary for the promotion of women in politics, since for centuries women were discriminated. The opposers support that this system favours the promotion of women with low qualifications while capable men are discriminated.

Women's participation in Public Life is linked with the general position of women in society. A global investigation of the phenomenon necessitates the consideration of historical, social, political, economical, personal and other factors. Since ancient times the man's role was outside the house, in the world, while the woman's place was in the house. Through family, society and school boys and girls are brought up with different values, according to their roles. The socialisation into their different gender roles influence their educational, employment and other aspirations and orientations.

Women won the right to vote only at the beginning of the 20th century. In 1890, the State of Wyoming was the first State in the United States where women gained the right to vote, while Norway was the first European country that gave the franchise to women -in 1910 for administrative and 1913 for political elections. By 1945, only 30 countries gave to women the right to elect and be elected. Considering that women are very new in this area, the importance of their participation even if it is lower than expected, can be appreciated.

CONCLUSIONS

Socio-economic changes and women's struggles contributed to the recognition of equal political rights to women with men, during the first half of the 20th century.

Political and socio-economic changes in Cyprus after its independence in 1960, brought about an improvement in the position of women in the family, the education, the labour force and the society in general.

Cypriot women's participation in public life is very low. Their participation in Government elected and appointed posts, the leadership of Political Parties and Trade Unions as well as positions of authority in the Means of Communications is negligible.

Women's participation iin public life is affected by the traditional social values about male and female gender roles. Women's educational and occupational low aspirations as well as their double role as- workers, - mothers and housewives hinder their involvement in public life.

There is a long way to go until women will be equally represented in public life and the other aspects of society. Women's participation in public life cannot be improved only with legal measures; it is a social phenomenon where attitudes and values need to be changed.

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STATISTICAL ANALYSIS OF RESULTS FROM CURRENT TESTING METHODS FOR THE PREDICTION OF AGGREGATE DURABILITY/ SOUNDNESS

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ABSTRACT

The relationships between the results of various tests used for the acceptance of aggregate have been examined to determine whether significant correlation exists. Data for specific gravity, water absorption, porosity, magnesium sulphate soundness, aggregate crushing value, impact value, 10% fines dry strength, Los Angeles value, flakiness and sulphates (S03) content have been analysed for diabase and basal group coarse crushed basic igneous aggregate. A cross correlation statistical analysis between test methods was carried out in order to identify any quick and simple test methods which can be used as substitutes for more cumbersome, complex or time consuming tests. It is concluded that no one engineering test can be used as an absolute predictor of aggregate performance. Combinations of common mechanical and physical tests such as water absorption, specific gravity, flakiness index, aggregate impact, 10% fines, Los Angeles abrasion and magnesium sulphate soundness can be used to help assess potential durability.

INTRODUCTION

This paper presents an evaluation of several current testing methods to control quality of coarse crushed basic igneous aggregate for use in the road and concrete construction industry by examining the relationships between the test results obtained by a number of different routine aggregate test procedures.

When aggregates are tested for their suitability as construction materials, the intention is to obtain material with performance adequate for the design life of the construction. The term aggregate durability as defined by PG Fookes is "the ability of an aggregate to last in its intended use without noticeable reduction in performance, under whatever type of applied external force is experienced". The broad definition of aggregate performance - durability, the wide range of variables affecting service life of aggregates and the effect of aggregate quality on the overall performance of the road and concrete constructions indicate the difficulty of developing a material test to assess performance or durability. Various studies have developed several tests or proposed modifications to tests for better predictions and precision, but, to date, no single test has been successful. The controversy behind the results and the many tests used, demonstrate the level of influence that variable conditions in design, construction and weather, have on the relationship between laboratory and field.

SIGNIFICANCE OF THE STATISTICAL ANALYSIS

The soundness test, despite its drawbacks, has proved to be an accurate method of predicting the performance of the so-called "hard" rocks, in the laboratory, while several authorities consider it as the only suitable test available at present.

Taking into account this consideration, the primary purpose of this study was set up to be the investigation of the relationship between the sulphate (magnesium) soundness test and existing aggregate quality tests that are simpler to perform. If a strong relationship is found, then the soundness value of an aggregate could be estimated by performing the easier test. The benefit from this would be faster test results probably at lower cost but at comparable acceptability.

Using statistical inferences and modeling, equations that describe the relationships between tests can be

developed, which, if found strong and significant, can be used for future purposes to predict a soundness test result from the result of another test. Additionally, if a test is found to correlate strongly with the soundness test, then inverse prediction could be used to estimate a limit for the test from the respective limit of the soundness test. The outcome would be a direct use of the new test instead of transforming results to soundness values.

STATISTICAL TREATMENT OF DATA

A total of twenty aggregate samples were collected from a single quarry source, during a period of one year at different time intervals as the quarry faces were progressing. The samples were tested at the Higher Technical Institute, placing greater emphasis on the consistency of the testing procedures, i.e. tests were carried out by the same operator, using the same techniques, equipment and methods. Table 1 shows the results of the tests performed.

The statistical analysis applied involved fitting regression lines to the data, calculating the respective correlation coefficients and carrying out a multivariate regression analysis.

The first step of the analysis was to visualize the relationship of the independent (also called the regressor) variables with the dependent (or response) variable. Each physical, mechanical or chemical property describes a small or large part of the overall durability - soundness of the aggregate material. Therefore, independent variables are all the tests performed in order to be used in correlation and prediction of another variable. The dependent variable is the test to be predicted i.e. soundness test. This relationship was visualized using scatter plots.

Scatterplots are very useful because they show visually the relationship between two variables, the direction of the relationship (positive or negative) and the type of the relationship (linear or non-linear). The plots can then be used to decide which variables should be included in models and what type of data transformations should be applied. Additionally, they can assist with the detection of multicollinearity problems in cases where independent variables are strongly linearly interrelated.

Although a scatterplot is an essential first step in studying the relationship between two variables, it is often useful to quantify the strength of the relationship by calculating a summary index. One commonly used measure is the Pearson correlation coefficient, denoted by r. The correlation coefficient is a measure of the way in which two variables co-vary and it yields values between +1 and -1. The correlation coefficient is also an indication of linearity; values near +1 or -1 indicate strong correlation as well as strong linear relationship between variables.

Linear regression analysis provides a simple technique for establishing a functional linear relationship between the dependent variable (and one or more independent variables. One of the most commonly used procedures for fitting a line to the data is the method of least squares. This method results in a line that minimizes the sum of squared vertical distances from the data points to the line. The relationship between the variables is expressed in an equation with the form:

$$\psi = \alpha_0 + \beta_1\chi_1 + \beta_2\chi_2 + ... + \beta_n\chi_n + \varepsilon$$

where:

ψ= dependent variable

$\chi_1, \chi_2 ..... \chi_n$= independent variables

$\alpha_0, \beta_1, \beta_n$= regression coefficients, and

ε = error term

When this equation contains one independent variable it is called a bivariate or simple linear regression equation and when more, a multiple regression equation. The advantage with simple regression equation, as applied to this study, is that only one laboratory test is needed to estimate the corresponding

soundness test value. The disadvantage is that only a part of the variation in soundness may be explained by the variation in the one single test. Should this be the case, other laboratory tests will be needed in the model to account for the additional variation in soundness. The multiple regression thus offers a stronger relationship but requires additional tests which add to the time and cost of performing the tests.

STATISTICAL ANALYSIS

In the following sections, the degree to which the results of the various tests can be related is examined for the pairs of test procedures mentioned.

1. Relationships between soundness and other tests

The brief discussion that follows refers to the relationships between soundness and other test parameters.

Soundness (MgS04) vs Specific Gravity (ssdRD)

In general the values of aggregate soundness decrease as the values of specific gravity increase. Note that, the smaller the soundness value, the more sound the aggregate is said to be, and therefore more durable. This indicates a negative relationship as expected. However, the range of values of relative density (2.61 to 2.69) was too small to indicate clearly the variation in soundness. Note that the distribution of representative values of the whole range of possible densities, say 2.50 to 2.75 for diabase aggregate, does not exist. Also, in this set of data, a gap exists for the ssdRD, in the range between 2.69 to 2.75. It can be clearly concluded that if the single isolated value of 2.75 for ssdRD was not there, then the relationship between soundness and density would have been insignificant with this set of data.

Soundness vs Water Absorption (Graph 1)

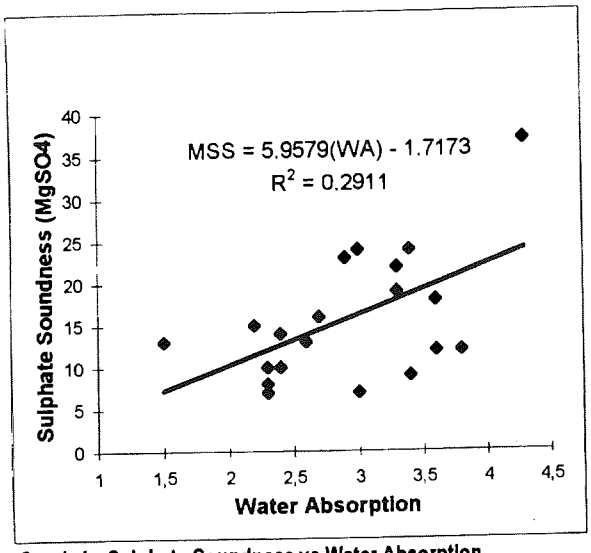
The general trend of the aggregates tests showed higher soundness losses with increasing absorption, indicating a positive relationship. A relationship with relatively good correlation was expected between the two test methods. However, from the regression analysis carried out, the strength of the relationship was found to be relatively poor (R^2=0.2911). The scatter of the results giving this relationship, indicates that water absorption by itself, does not provide conclusive evidence of soundness problems.

Soundness vs Porosity

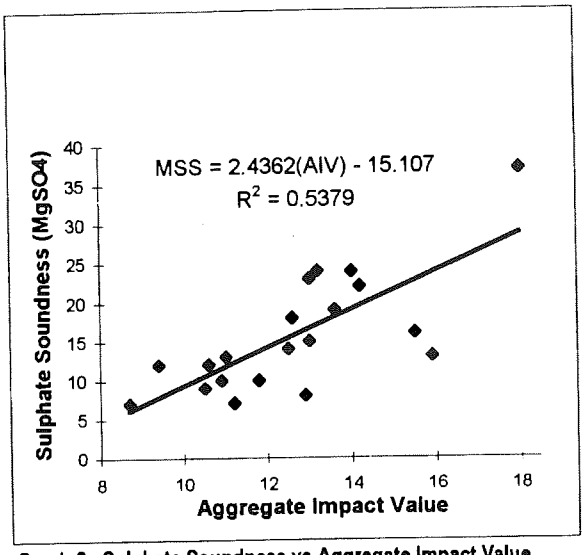
The apparent porosity, defined in BS 1902:Section 3.8:1989 Methods for testing refractory materials, is a combination of the saturated and surface-dried (ssd) relative density and water absorption. Here, it was used in an attempt to investigate the possibility of a better relationship with the soundness test. However, no improvement in the relationship with soundness has been observed. This is because the ssd relative density values were more or less constant. The size of the pores, their distribution and other factors such as microcracking and the degree of cementation of grains within an aggregate particle, all have significant effects on performance.

Soundness vs Mechanical tests (ACV, AIV, TFV, LA)

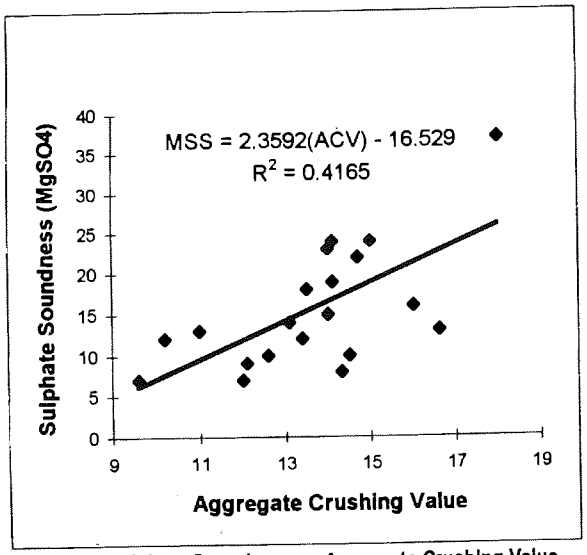
The scatter plots indicate basically linear relationships between soundness and mechanical tests. Some of these relationships are shown in Graphs 2 - 5. In the case of 10% fines value (TFV) the results were transformed to their natural logarithm in order to reduce the difference in variance between high and low TFV values. Transformations are usually performed to improve linearity and correlation between variables. The variance of the test results was small and therefore transformations on other tests results were not performed. Aggregate shape and testing in a dry state are the main factors influencing the relationships between mechanical test methods and the soundness test. Routine samples vary in shape so that well correlated straight line relationships between mechanical test methods and the soundness test are unlikely. Again, it can be said that the mechanical tests do not explain fully but only in part the soundness of aggregates.



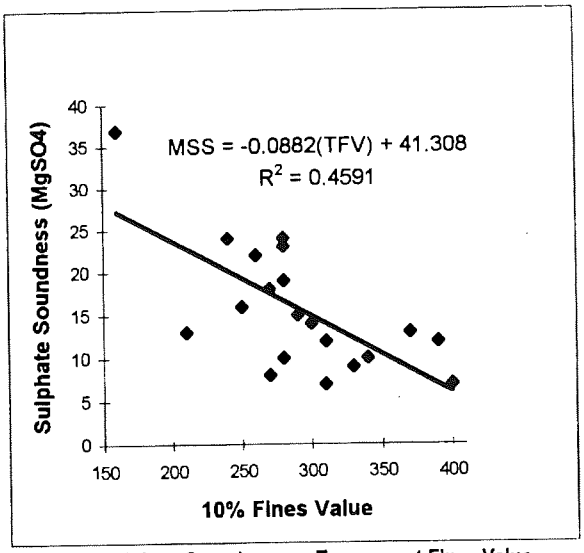
Graph 1 - Sulphate Soundness vs Water Absorption



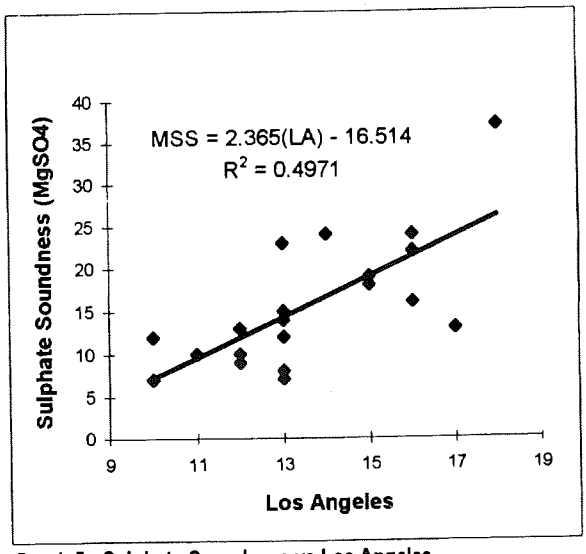
Graph 2 - Sulphate Soundness vs Aggregate Impact Value



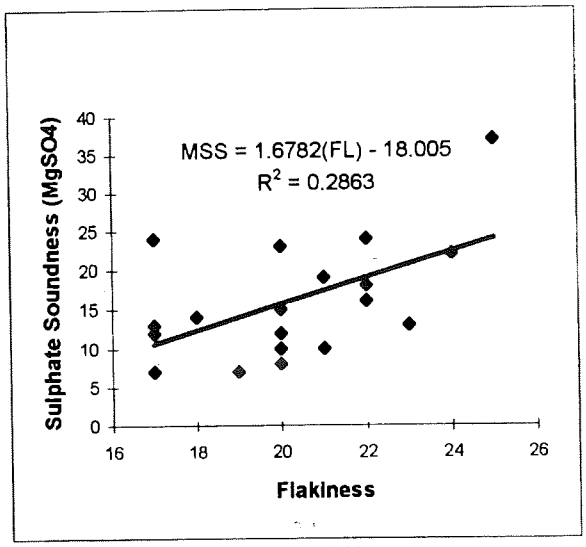
Graph 3 - Sulphate Soundness vs Aggregate Crushing Value



Graph 4 - Sulphate Soundness vs Ten percent Fines Value



Graph 5 - Sulphate Soundness vs Los Angeles



Graph 6 - Sulphate Soundness vs Flakiness

Soundness vs Flakiness Index (Graph 6)

Flaky particles fracture more easily under pressure. The soundness test subjects the various aggregate particles to internal pressures caused by the salt solution entering the pores and expanding by crystallization. The scatterplot shows that there is a positive linear relationship between soundness test and flakiness index. The more flaky the particles are, the more susceptible become to the internal pressures set up by the salt solution causing disintegration.

Soundness vs SO_3 content

Sulphur in sulphite and/or sulphate minerals expressed as SO_3 content are considered deleterious substances. The SO_3 content is a standard chemical test (BS 1377, CYS 64:1986) carried out in Cyprus for the crushed igneous (diabase and basal group) aggregates. The SO_3 content in a rock mass is somehow a characteristic of the quarry area during the genesis of the rock. It was produced when hydrothermal effects were taking place in fault zones. SO_3 content has very little to do with the weathering state of the rock mass which influences the various properties of the aggregate. The results of SO_3 content have not been used in the correlation analysis since they cannot be correlated with the other test results. However, the presence of these deleterious substances in the aggregate cannot be overlooked since they greatly influence the performance of concrete and road constructions.

2. Relationships among other pairs of aggregate tests

Graphs 7 - 12 show some of the relationships among pairs of aggregate property tests (ssdRD, WA, ACV, AIV, TFV, LA and FL) examined. The strongest correlations ($R^2>0.85$) were found to exist between the aggregate strength tests, i.e. Aggregate Crushing Value (ACV), Aggregate Impact Value (AIV), Ten Percent Fines Value (TFV) and Los Angeles abrasion value (LA). Strong linear relationships were expected between these tests because they measure almost the same properties of the aggregate. From the above strong linear relationships it can be concluded that there is no need to carry out all strength tests but only one.

Flakiness index test values have shown relatively strong correlations ($R^2\approx0.70$) with the mechanical test methods. Very flaky and elongated particles are more difficult to compact properly and they fracture more easily under external forces. This indicates that flaky particles influence the engineering properties of an aggregate which in turn have a bearing on the performance of the concrete or road construction.

The specific gravity and water absorption tests showed no correlation with the mechanical tests methods. The main reason for this is that all mechanical tests were carried out in dry condition. In actual circumstances though the situation is completely different. The correlation coefficient between these two physical tests was found to be 0.7. This could have been higher, but again the range of values of specific gravity was too small to indicate clearly the variation in water absorption.

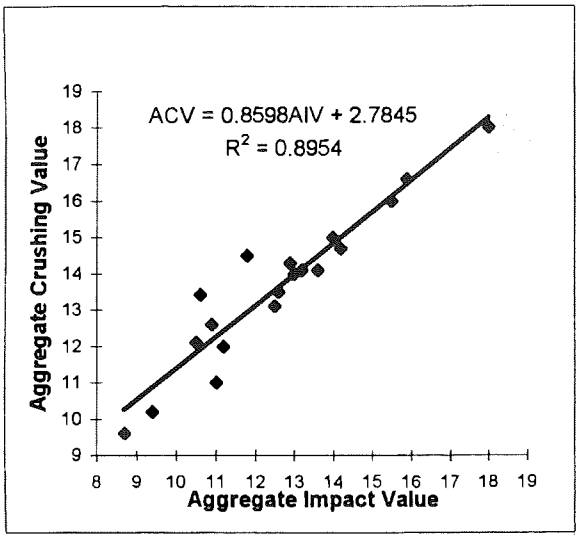
The linear regression models developed from the bivariate analysis between soundness and other laboratory tests are shown in Table 2. All models presented had significant "t" tests results (<0.05). All others have not been included since they have only a limited importance (>0.05).

The results of the aggregate samples tested showed little variation. They were not uniformly distributed but concentrated within the acceptable limits or just outside them. Therefore, it can be concluded that the models derived from the regression analysis represent only that range covered by the results.

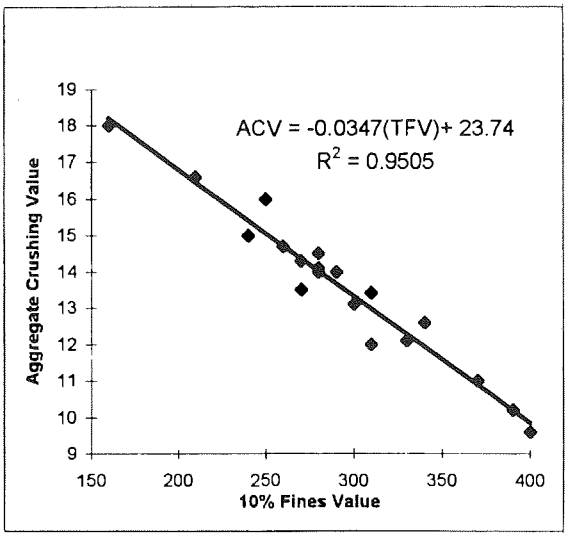
MULTIPLE REGRESSION ANALYSIS

In order to avoid multicollinearity problems, and have models with inflated R^2, only one of the mechanical tests, which was strongly correlated, was used in the derivation of multiple regression models.

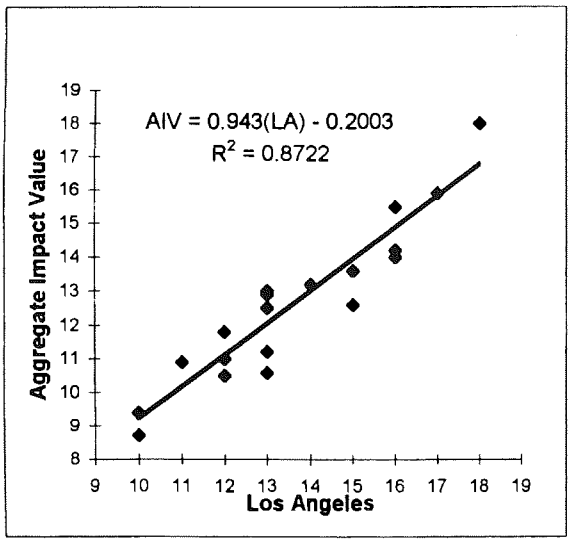
Multicollinearity is a problem that arises when two or more of the independent variables are found to be highly correlated with each other. If two variables contribute overlapping information, the first β_1 parameter (slope) may be overestimated while β_2 tends to be underestimated.



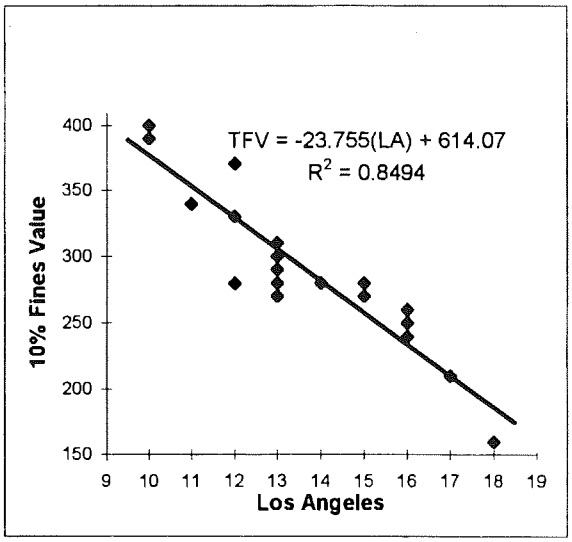
Graph 8 - Aggregate Crushing Value vs 10% Fines Value



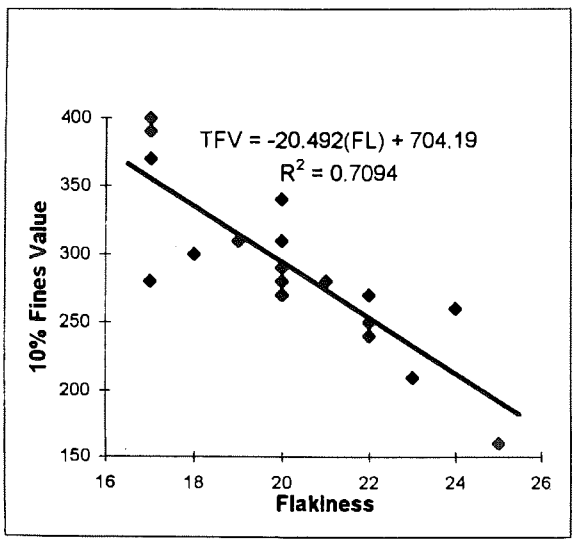
Graph 9 - Aggregate Crushing Value vs Los Angeles



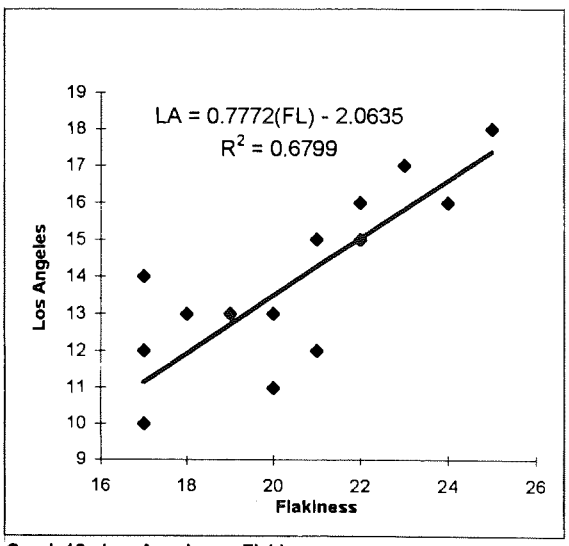
Graph 9 - Aggregate Impact Value vs Los Angeles



Graph 10 - Ten percent Fines Values vs Los Angeles



Graph 11 - Ten percent Fines Value vs Flakiness



Graph 12 - Los Angeles vs Flakiness

TABLE 1 - TEST RESULTS

SN	DC	SG	ssdRD	WA	Poros	MSS	ACV	AIV	TFV	LA	FL	SO3
S1	30/10/91	2.59	2.65	2.2	5.70	15	14.0	13.0	290	13	20	1.21
S2	30/10/91	2.61	2.69	2.6	6.82	13	11.0	11.0	370	12	17	1.33
S3	30/10/91	2.60	2.68	3.0	7.81	24	15.0	14.0	240	16	22	3.34
S4	30/10/91	2.50	2.61	4.3	10.76	37	18.0	18.0	160	18	25	0.96
S5	11/02/92	2.60	2.66	2.3	5.98	8	14.3	12.9	270	13	20	0.48
S6	11/02/92	2.55	2.61	3.6	9.07	12	13.4	10.6	310	13	20	0.64
S7	23/03/92	2.60	2.67	2.3	6.00	10	12.6	10.9	340	11	20	0.40
S8	23/03/92	2.57	2.63	3.3	8.40	22	14.7	14.2	260	16	24	0.05
S9	08/04/92	2.54	2.61	3.6	9.07	18	13.5	12.6	270	15	22	0.10
S10	08/04/92	2.55	2.61	3.3	8.34	19	14.1	13.6	280	15	21	0.11
S11	17/06/92	2.60	2.66	3.0	7.75	7	12.0	11.2	310	13	19	0.20
S12	17/06/92	2.61	2.68	3.8	9.81	12	10.2	9.4	390	10	17	0.44
S13	24/07/92	2.63	2.69	2.3	6.05	7	9.6	8.7	400	10	17	
S14	24/07/92	2.60	2.68	3.4	8.81	9	12.1	10.5	330	12	25	0.14
S15	08/08/92	2.61	2.67	2.4	6.26	14	13.1	12.5	300	13	18	0.35
S16	08/09/92	2.61	2.67	2.4	6.26	10	14.5	11.8	280	12	21	0.84
S17	08/09/92	2.60	2.67	2.9	7.52	23	14.0	13.0	280	13	20	
S18	21/10/92	2.71	2.75	1.5	4.06	13	16.6	15.9	210	17	23	
S19	21/10/92	2.55	2.63	3.4	8.65	24	14.1	13.2	280	14	17	
S20	21/10/92	2.60	2.66	2.7	6.99	16	16.0	15.5	250	16	22	

TABLE 2 - LINEAR REGRESSION MODELS

Model	R^2	Number of Samples
MSS = - 97.39 (ssdRD) + 274.61	0.208	20
MSS = 5.96 (WA) - 1.72	0.291	20
MSS = 2.40 (Poros) - 2.38	0.276	20
MSS = 2.36 (ACV) - 16.53	0.416	20
MSS = 2.44 (AIV) - 15.11	0.538	20
MSS = - 0.09 (TFV) + 41.31	0.459	20
MSS = - 25.48 ln (TFV) + 159.71	0.511	20
MSS = 2.36 (LA) - 16.51	0.497	20
MSS = 1.68 (FL) - 18.01	0.286	19
LA = 0.777(FL) - 2.06	0.680	19
TFV = - 20.49 (FL) + 704.19	0.709	19
TFV = - 23.76 (LA) + 614.10	0.849	20
AIV = 0.746 (FL) - 2.37	0.627	19
AIV = 0.94 (LA) - 0.20	0.872	20
AIV = - 0.037 (TFV) + 23.41	0.894	20
ACV = 0.72 (FL) - 0.88	0.696	19
ACV = 0.811 (LA) + 2.61	0.782	20
ACV = - 0.035 (TFV) + 23.74	0.951	20
ACV = 0.860 (AIV) + 2.78	0.895	20
ssdRD = - 0.036 (WA) + 2.77	0.497	20

TABLE 3 - MULTIVARIATE LINEAR MODELS

Model	R^2	Number of Samles
MSS1 = - 0.632 (FL) + 2.724 (AIV) + 5.849 (WA) - 22.781	0.799	19
MSS2 = - 0.667 (FL) - 77.845 (ssdRD) + 2.783 (AIV) + 200.972	0.651	19
MSS3 = - 0.544 (FL) + 5.681 (WA) - 0.095 (TFV) + 38.145	0.709	19
MSS4 = - 0.295 (FL) + 5.068 (WA) + 2.227 (LA) - 23.148	0.691	19
MSS5 = - 0.519 (FL) + 6.218 (WA) + 2.638 (ACV) - 27.640	0.709	19
MSS6 = - 0.605 (FL) + 2.431 (Poros) + 2.731 (AIV) - 24.606	0.802	19
MSS7 = 2.314 (AIV) + 5.378 (WA) - 29.243	0.774	20
MSS8 = - 72.692 (ssdRD)+ 2.243 (AIV) + 180.627	0.650	20
MSS9 = 5.174 (WA) - 0.081 (TFV) + 24.208	0.676	20
MSS10 = 4.657 (WA) + 2.099 (LA) - 26.468	0.688	20
MSS11 = 5.646 (WA) + 2.274 (ACV) - 31.832	0.677	20
MSS12 = 2.226 (Poros) + 2.348 (AIV) - 30.710	0.787	20

TABLE 4 - COMPARISON BETWEEN ACTUAL AND PREDICTED SOUNDNESS VALUES

	PREDICTED MSS VALUES (R^2)											
ACTUAL MSS	MSS1 (0.80)	MSS2 (0.65)	MSS3 (0.71)	MSS4 (0.69)	MSS5 (0.71)	MSS6 (0.80)	MSS7 (0.77)	MSS8 (0.65)	MSS9 (0.68)	MSS10 (0.69)	MSS11 (0.68)	MSS12 (0.79)
15	12.86	17.52	12.21	11.05	12.59	12.66	12.67	17.15	12.10	11.06	12.43	12.51
13	11.65	10.84	8.52	11.74	8.72	11.72	10.19	9.76	7.69	10.83	7.86	10.29
24	19.00	16.64	20.42	21.20	19.17	19.29	19.29	17.21	20.29	21.09	19.22	19.54
37	35.60	31.22	33.77	31.36	33.61	35.59	35.53	31.27	33.50	31.34	33.38	35.51
8	13.17	16.47	14.68	11.56	14.00	13.06	12.98	16.20	14.24	11.53	13.67	12.89
12	14.51	13.96	18.27	18.15	19.71	14.29	14.65	14.68	17.72	17.58	18.97	14.37
10	7.72	10.12	8.03	7.11	9.52	7.66	8.35	10.99	8.57	7.33	9.81	8.25
22	20.03	19.75	19.14	22.13	19.20	20.08	21.36	21.30	20.22	22.48	20.23	21.33
18	18.69	18.19	20.98	22.01	18.94	18.54	19.27	19.16	20.96	21.78	19.19	19.06
19	20.30	21.64	18.87	20.79	19.18	20.10	19.97	21.41	18.60	20.39	18.86	19.78
7	13.27	12.40	15.40	15.40	12.81	13.32	12.81	12.39	14.62	14.79	12.39	12.83
12	14.31	7.17	13.43	13.37	14.07	14.63	12.95	6.90	12.28	12.22	12.82	13.20
7	3.63	4.44	3.96	5.76	3.16	3.57	3.26	4.60	3.71	5.23	2.98	3.18
9							13.34	9.36	15.07	14.55	14.88	13.56
14	13.93	15.91	13.49	12.66	12.50	13.85	12.59	14.58	12.33	12.00	11.51	12.57
10	10.13	11.96	13.76	9.54	14.64	10.13	10.97	13.01	13.95	9.90	14.69	10.93
23	16.95	15.96	17.14	14.60	16.94	17.09	16.44	15.70	16.53	14.32	16.38	16.56
13	14.77	15.81	14.20	15.53	13.54	14.78	15.62	16.39	14.96	16.20	14.39	15.67
24	18.53	17.63	18.35	18.48	18.76	18.55	19.59	19.05	19.12	18.75	19.43	19.53
16	21.33	22.37	17.77	19.68	19.94	21.41	21.14	22.03	17.93	19.69	19.80	21.25

The term R^2, the multiple coefficient of correlation, provides a measure of the fit of the multivariable regression model. That is, R^2 gives the proportion of the total sum of squares explained by the predictor variables. The remainder is explained by the omission of important information-contributing variables from the model, and experimental error. R^2 takes values in the interval $0 \leq R^2 \leq 1$. A small value of R^2 means that the predictor variables contribute very little to the prediction of soundness; a value of R^2 near 1 means the predictor variables provide almost all the information necessary for the prediction of soundness.

Table 3 shows all the statistically significant models with significant and non-collinear parameters, that describe the relationship of the various tests with soundness test. The predicted soundness values were calculated from these models for comparison with the actual soundness test values. Predicted and actual values are shown in Table 4.

DISCUSSION / CONCLUSIONS

An assertion that two aggregate property tests are correlated implies that both tests are measuring related properties of an aggregate. By nature the properties of even the same type of aggregate, as measured by such tests, are apt to be quite variable. Among the most commonly blamed sources of variability are locational differences within and between quarries, particle size and shape and the degree of weathering.

When the correlation coefficient drops below 0.8-0.9 there are clearly some "disturbing factors" in the relationships. If the statistical test for significance shows that there is a relationship (signif. $F<0.05$), it is important to identify these "disturbing factors" so that an explanation is available for the dispersion of results of testing which might lead to improved test methods.

It is essential to point out that the purpose of the statistical analysis was to investigate the relationship between the soundness test and other laboratory tests, and develop models describing this relationship. A high correlation does not necessarily mean that a particular test predicts better the performance of aggregates in the field of use. Results should be examined together with field data to be able to conclude which test is more reliable.

To be sure that a reliable analysis, giving sound conclusions about the relationships between tests has been performed, a large number of aggregate samples is required covering all possible ranges of soundness values. This was not possible with the data available.

It has been observed that the major problem in the correlation analysis was the inability of the tests to detect aggregates with high soundness values. All tests predicted that they were good aggregates while soundness test rejected them from use. Aggregate failing soundness test (18% loss for magnesium sulphate) never exceeded specification limits set out for strength tests. This suggests that specification limits for ACV (25%), AIV (23%) TFV (160KN), LA (25%) tests should be re-examined if these tests are to be used as substitutes for the soundness test.

In general, the bivariate regression analysis has shown that all test methods had relatively low correlation with soundness. The low R^2 indicated that other tests should be added to the models to account for the variation in soundness not explained by the tests used. In engineering terms, it indicated that these tests and the soundness test measured different aggregate properties.

In an effort to provide a better basis for prediction, multivariate models were examined. The models derived from multiple regression have three or two independent variables. The disadvantage of this is that, in order to predict soundness, two or three tests should be performed on the same aggregate which adds to the time and cost. However time may be saved if tests are run simultaneously. The advantage of this procedure is that more accurate prediction can be obtained.

The independent variables used in the models were selected on the basis of avoiding multicollinearity problems. Previous correlation analysis has indicated that absorption and specific gravity can each be used (not simultaneously) in conjunction with other tests, without causing collinearity problems. The same applies to the strength tests (AIV, ACV, TFV, LA) which are highly correlated and therefore measure similar properties of the aggregate.

From the above considerations, the selection of the variables to be used in the models was now easier. Specific gravity or water absorption or porosity was used in the models. The porosity as mentioned before is a combination of the specific gravity and water absorption. Finally, from these three choices, water absorption was found to be a better predictor. The main reason was the small variation of specific gravity values with soundness. When combined with water absorption the porosity values have not shown significant increase in correlation with the soundness test.

The flakiness index test was also used in the multivariate models because the amount of flaky particles can affect considerably the other properties of the aggregate.

From the foregoing it should be clear that no single engineering test method can be considered an absolute predictor of aggregate quality. An assessment of material durability in-service cannot be given unless all factors affecting the durability are considered, including rock quality, hydrological regime, climate, topography, the type of structure and imposed forces (dynamic or static). The models derived can be considered as measuring only two of the five parameters which make up a full assessment of potential durability. In the future it is hoped to weigh the models so that some assessment of topography, hydrological regime and climate can be included within the models to take into consideration the expected site environmental conditions.

An obvious need as emphasized earlier is to accumulate a large database of various test methods and results on a much wider range of rock and aggregate materials. This would allow improved and more reliable statistical regressions to be developed, and the inclusion by substitution of more complicated test methods.

Ultimately the most useful area of development would be the assessment of change in performance with time. For example, an estimate of the rate of degradation of a particular material with time could be given by testing of existing structures within various topographic, climatic and hydrological regimes. This could be used for prediction of suitability of engineering materials under similar circumstances.

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Key to symbols

SN - Sample Number

DC - Date Collected

SG - Specific Gravity (BS 812)

ssdRD - saturated surface dry Relative Density (BS 812)

WA - Water Absorption (BS 812)

Poros - Prosity [(ssdRDxWA)/(100+WA)] x 100 (BS 1902)

MSS - Magnesium Sulphate Soundness (BS 812)

ACV - Aggregate Crushing Value (BS 812)

AIV - Aggregate Impact Value (BS 812)

TFV - Ten percent Fines Value (BS 812)

LA - Los Angeles (ASTM C131)

FL - Flakiness Index (BS 812)

SO_3 - Sulphates (CYS 64, NF-P18-582)

THE IMPROVEMENT OF THE SURFACE FINISH OF A LATHE CUTTING PROCESS USING DESIGN OF EXPERIMENTS

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ABSTRACT

An increasing number of quality control managers and practitioners are currently using Design of Experiments (DOE) in process and product reliability improvements. This paper describes step by step the design and execution of an experiment conducted at the Higher Technical Institute in colaboration with one of the biggest water pump manufacturers in Cyprus.

The objective of the experiment was to optimise the surface finish of grey cast iron shafts. The paper includes a detailed analysis of how experimental factors related to the lathe cutting process affected the surface finish and how by the use of Taguchi methodologies the optimum results were achieved in a relatively short time.

INTRODUCTION

Statistically designed experiments received a great deal of attention and use as a product and process improvement tool, especially the approach advocated by Dr. Genichi Taguchi. The Japanesse Guru involved in quality engineering spent most of his life to improve quality and reduce costs in production. Taguchi's ideas are divided into five main categories :

(I) Total loss function
(ii) Design of production, services and processes
(iii) Reduction in variation
(iv) Statistically designed experiments.
(v) Robust Design

The purpose of this paper is to provide a comprehensive case study on a successful use of statistically planned experiments used at the Higher Technical Institute in collaboration with a manufacturing firm, to design and execute an experiment, to optimise some important parameters that are effecting the lathe cutting process and to improve the surface finish of the shaft's design.

BACKGROUND

Statistically designed experiments can be used to identify settings of process parameters to improve performance, quality and drastically reduce cost and time. Variables effecting performance are either design parameters or sources of "noise". Nominal settings of design parameters define specifications for the product or process and "noise" are variables that couse the performance characteristics to deviate from target values. [1] These key noise factors that create most of the problems should be identified and included in the experiments. The object of these experiments is to optimise the process by minimising the effect of these variables on this process. This can be achieved by systematically varying settings and comparing the effect of these noise factors for each experimental run.

The main advantage of Design of Experiment (DOE) method is the minimisation of the number of experiments required to optimise a process. For example where 128 experiments are required for a process optimisation, 8 are enough if the method of *orthogonal arrays* is used.

Dr Taguchi has modified the Latin square matrix into an orthogonal array. Orthogonal array is considered the best, for the reason that it requires a minimum number of experiments and with a high level of confidence in finding the best combination of the factors under investigation. The surface finish produced during a CNC machining is considered to be one of the most important parameters for reducing the wear of the main shaft of the submersible well pump.

THE EXPERIMENT

Eight components (axles) have been turned on a lathe with different combination of parameters in accordance with L_8 orthogonal array. At the end, measurements of the surface texture were taken at different points across their length .

The array used in this project is the $L_8(2^7)$ shown in table 1 sellected from common orthogonal arrays [2].

Table 1. The L_8 orthogonal array used in Taguchi Experiment

TEST	FACTORS						
	A	B	C	D	E	F	G
1	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2
3	1	2	2	1	1	2	2
4	1	2	2	2	2	1	1
5	2	1	2	1	2	1	2
6	2	1	2	2	1	2	1
7	2	2	1	1	2	2	1
8	2	2	1	2	1	1	2

The eight stands for number of experiments the 7 is the number of factors effecting the experiment, and 2 is the values for each factor. Factor levels are shown by numbers, in our case 1 or 2 since our experiment handles only two level factors. Each row shows a combination of factor levels to be run in the experiment. Using the background theory and the practical experience of the manufacturing firm all the variable parameters effecting the surface finish of a CNC lathe cutting process were identified. Through team work those parameters were grouped, plotted on a couse and effect diagram and finally reduced to the seven most important factors. It has been decided to examine those factors in two levels mainly because of the suggestions of the production team already experimenting on this matter. Table 2 shows the factors and levels used for the optimization process.

The axles were all tested for dimensions, hardness, material and were turned to eliminate any irregularities. The eight components (axles) were turned with different combination of parameters in accordance with table 1. The *surface finish* was then measured at different points (5) across the overall length and the average value obtained.

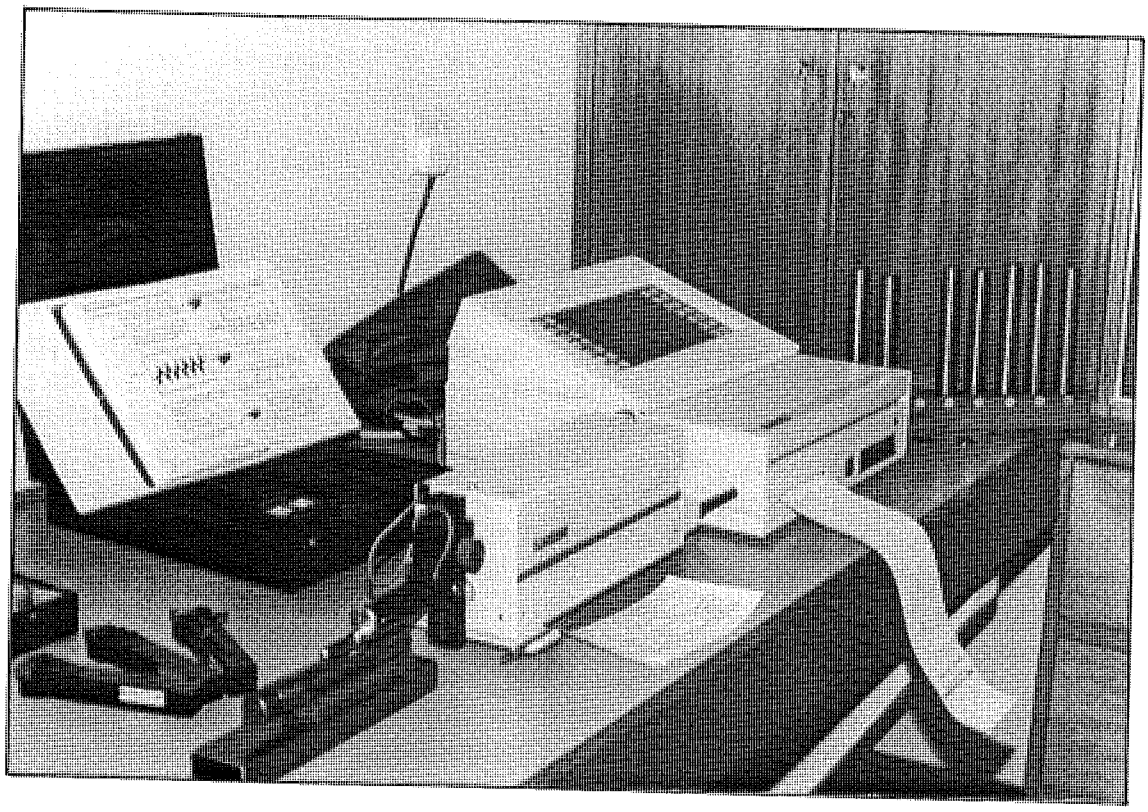
The experiments were carried out on the same lathe and two types of toolholders (the 60° insert and

Table 2. Factors and levels for optimization

FACTORS	LEVELS	
	1	2
A. Cutting Speed	1700 rev/min	2500 rev/min
B. Feed	0.25 mm/rev	0.4 mm/rev
C. Depth of cut	0.15 mm	0.3 mm
D. Clearance angle	8^0	9^0
E. Approach angle	90^0	95^0
F. Insert type	60^0	80^0
G. Cutting fluid	WITH	WITHOUT

80° insert) were used according to the requirements of each experiment. A new tip was used for every experiment.

For example test 1 combined the seven factors A-G only at level 1. In other words these factors take values according to level 1 ie combination factors is A_1 B_1 C_1 D_1 E_1 F_1 G_1 Test 2 used factors from both level 1 and level 2 i.e. combination for test 2 is A_1 B_1 C_1 D_2 E_2 F_2 G_2. Similarly the rest of the combinations have been developed. All surface finish measurements were taken on a Talisurf surface finish measuring apparatus. An example of this surface finish is shown on figure 1. The arrangement for the whole experiment is shown in photograph below.



The complete apparatus arrangement and work pieces

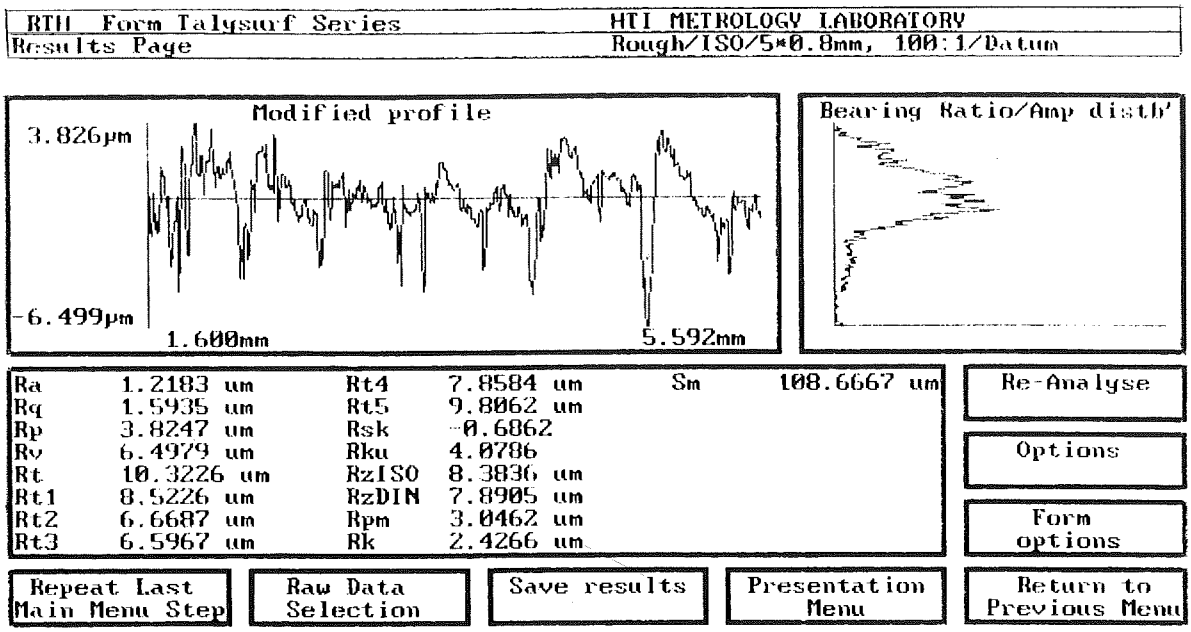


Figure 1. The Talisurf profile print out of surface finish

The next step was to average all the surface finish (Ra) values and create the table 3. Out of this table the overall average value for Ra was found to be Ra= 4.045385 µm.

Table 3. The orthogonal array with averages and culculations

TEST	FACTORS							AVERAGE SURFACE FINISH
	A	B	C	D	E	F	G	Ra (µm)
1	1	1	1	1	1	1	1	2.91976
2	1	1	1	2	2	2	2	2.10732
3	1	2	2	1	1	2	2	5.0093
4	1	2	2	2	2	1	1	6.58242
5	2	1	2	1	2	1	2	2.93624
6	2	1	2	2	1	2	1	2.88446
7	2	2	1	1	2	2	1	4.13672
8	2	2	1	2	1	1	2	5.78686

Total Average value Σ Ra av = 32.36308 µm, Average finish Ra = 4.045385 µm

A_1 = (2.91976 + 2.10732 + 5.0093 + 6.5242) /4 = 4.1547µm

A_2 = (2.93624 + 2.88446 + 4.13672 + 5.78686) /4 = 3.93607µm

e.t.c.

For every column of table 3 the average value of each level was calculated. For example the average value of A_1 (factor A at level 1) is found by adding the corresponding Ra values and then divided by the number of A_1.

Summing up the Response table 4 was constructed.

Table 4. Response table

	A	B	C	D	E	F	G
LEVEL 1	4.1547	2.711945	3.737625	3.750505	4.150095	4.55632	4.55632
LEVEL 2	3.93602	5.378825	4.353105	4.340265	4.35321	3.53445	3.95993
DIFERENCE	0.21969	2.66688	0.61548	0.59976	0.203115	1.02197	0.59639
RANK	6	1	3	5	7	2	4

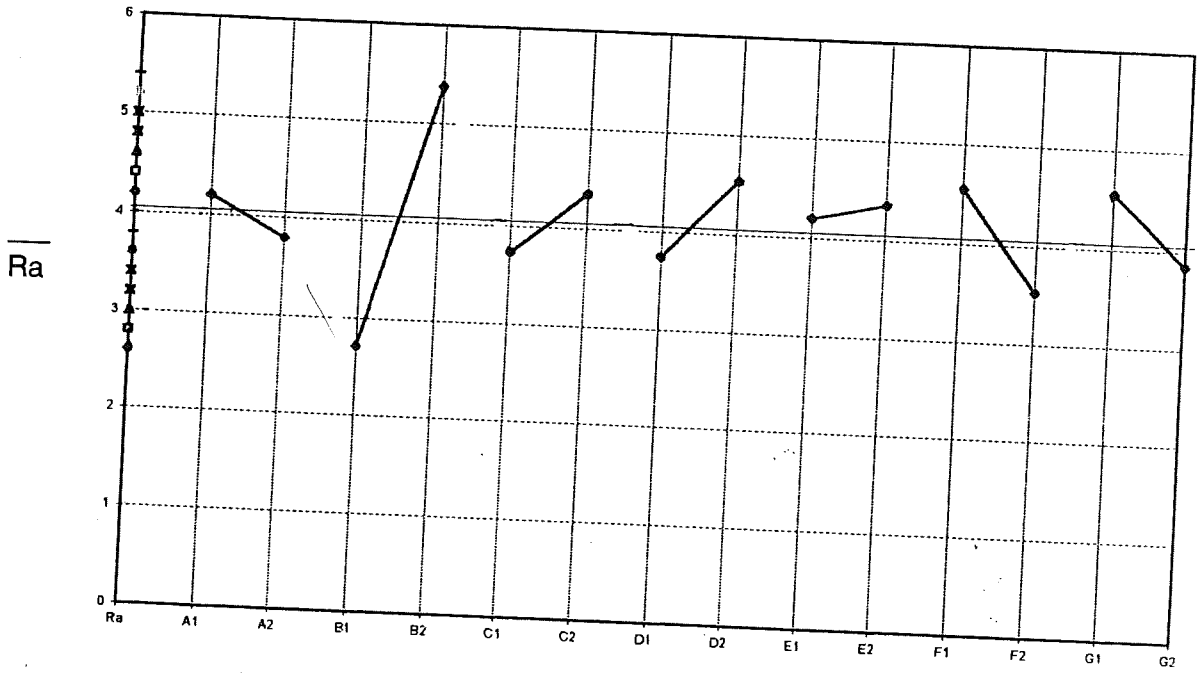
From table 4 it can be seen that the best combination of factors that give the optimum surface finish can be found i.e. A_2 B_1 C_1 D_1 E_1 F_2 G_2. Prediction and confirmation run were the next steps.

From table 4 the value y is calculated which can be characterized as the predicting distortion value of the surface finish utilizing the above given combination of parameters and this value is:-

Y= T+ (A2-T)+(B1-T)+(C1-T)+(E1-T)+(F2-T)+(G2-T)
i.e. Y=A2+B1+C1+D1+E1+F2+G2-6T
i.e. Y=1.5085

At this stage a response graph can be constructed getting the steepest slope as the most significant factor and keeping that fixed (see graph 1)

Graph 1. Graph out of responses



Now trying to make some changes to the best combination given we should keep factors A,B and F which are the most significant factors (slopes) of graph 1 constant and change some of the factors always taking into consideration the practicality of such a change. For example putting a thin slice of metal under the tool holder to change the clearance angle is OK to do so during an experiment, but not while using CNC lathes in a real manufacturing environment.. The result on changing the rest of the factors on the surface finish should give better or similar results.

Two confirmation run tests were performed one with optimum combination of factors and the other with the same combination but factor D at level 2. The results are shown in table 5.

Table 5. Confirmation run tests

TEST	FACTORS							SURFACE FINISH Ra (μm)					
	A rev/min	B mm/rev	C mm	D deg^0	E deg^0	F deg^0	G Fluid	A	B	C	D	E	AVERAGE
1	2500	0.25	0.15	8	90	80	Without	1.2218	1.3191	1.1084	1.2083	1.2125	1.21402
2	2500	0.25	0.15	9	90	80	Without	2.4695	2.3870	2.5223	2.3166	2.5505	2.44918

It is obvious that there is a great difference on the surface finish (table 8) obtained from the two tests proving that the best combinations are indeed those found with Taguchi method i.e. A_2 B_1 C_1 D_1 E_1 F_1 G_2.

Where :-

A Cutting Speed 2500 rpm
B Feed 0.25 mm/rev
C Depth of cut 0.15 mm
D Clearance Angle 8°
E Approach angle 90°
F Insert type 80°
G Cutting Fluid without

This combination results in an excellent surface finish Ra value of 1.21402 μm very close to the predicting distortion value y=1.5. This value is more than three times better than the average Ra value obtained in table 3 ($\overline{Ra}$ = 4.045 μm).

CONCLUSIONS

A Taguchi Experiment has shown the optimum combination of factors effecting the surface texture of a 25 mm diameter axle shaft used in the manufacture of water pumps in a Cyprus Manufacturing Firm. The optimum solution has been reached with the use of eight experiments instead of 128 and with excellent results.

This reduces drastically the time required for an engineer to reach a decision on what is the best combination of factors effecting the surface finish in days instead in Months. This has an effect on the quality, reliability and the cost of the finished product.

This method was first used in Cyprus by the Higher Technical Institute. It was proven under no doubt that Taguchi is a relatively simple and effective method for reaching the optimum combination in very little time and is advisable to be used in Industry without fear. It is a suggestion of combinations of factors

effecting the process and it can be proved right or wrong by just testing the right combination. There is nothing to loose here but a great benefit and profit to be made.

REFERENCES

1. *Total Quality Management* by John S. Oakland.

2. *Orthogonal arrays and linear Graphs* by G. Taguchi and S. Konishi, ASI.

3. *Taguchi methods* by A. Bendel, J. Disney and W.A. Pridmore, IFS.

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HTI Calendar of Activities for Academic Year 1995-1996

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SEPTEMBER

- Two hundred and fifty four (254) new students were enrolled on the regular courses of HTI: 64 for Electrical Engineering, 64 for Civil Engineering, 62 for Mechanical Engineering, 32 for Marine Engineering and 32 for Computer Studies.

- Mr C Pavlou, Senior Lecturer, and Mr Ph Sophocleous, Sports Master, participated in the "Universiade 95" which was held in Fukuoka, Japan, between 23 August - 3 September, organised by the International University Sports Federation (FISU). Mr Pavlou, who is a member of the Commission for study of University Sports (CESU), presided over the workings of one of the sessions of the Conference of CESU. Mr Sophocleous headed the Cyprus Athletic Delegation which participated in "Universiade 95".

- Dr. D Serghides' (Senior Lecturer) paper "Integrated Approaches for Energy Efficient Building Design" was presented as keynote paper for Architecture in the Solar World Congress, of the International Solar Energy Society, held in Harare from 9-16 September.

- Ms D Charalambidou-Solomi, Lecturer, attended the symposium on "Cyprus, Greece, Europe: Literary and Cultural Relations" which was held in Nicosia between 23-24 September within the framework of the European Cultural Month.

OCTOBER

- Dr. I Michaelides, Senior Lecturer, represented Cyprus in the "Workshop of Solar Power Modelling and its Applications" which was organised by the Commonwealth Science Council and took place in Perth, Australia, from 9 to 14 October. Dr. Michaelides was one of the speakers and gave a lecture on "Modelling and Simulation of Solar Systems".

- Mr P Masouras, Lecturer, headed the Cyprus Delegation, which participated in the Balkan Olympiade Informatics between 4-12 October.

- Dr. L Lazari, Lecturer, participated and presented exhibits in the "High Technology made in Greece" Exhibition, which was held in Thessaloniki between 4-8 October.

- Ms D Charalambidou-Solomi, Lecturer, attended two short courses on European Union within the framework of the MED-CAMPUS program, co-ordinated by ULB and organised at the Philoxenia Hotel in Nicosia between 5-14 October and 16-20 October.

- Mr S Spyrou, Senior Lecturer, participated in the Conference of Euro Exec of IEE Europe Regional Board, which was held in Netherlands from 13-15 October.

- Mr I Angeli, Laboratory Assistants, delivered a short course in overview of ISO.9000 on 16 October. The course was organised by HTI and CEA.

- Mr C Neocleous, Lecturer, visited the University of Brunel within the framework of the approved program of staff exchanges with Universities and Polytechnics, from 23-27 October.

- The HTI UNESCO Day was celebrated on Tuesday 24 October. Students and Staff visited the ancient Kurium archaeological site. Ms E Procopiou, from the Department of Antiquities outlined the history of the monuments. The visit ended with lunch in a nearby restaurant.

NOVEMBER

- The First Mid-Semester Examinations were held between 30 October and 3 November.

- Dr. A Stasis, Lecturer, visited the University of Warwick, U.K. , from 29 October to 4 November within the program of staff exchanges between HTI and Universities and Polytechnics abroad.

- Ms D Charalambidou - Solomi, Lecturer, was involved in the organisation of the International Conference of the Greek Research Centres: "Hellenism in a Global Village" which was held in Nicosia from 3-9 of November. Ms Solomi was also a member of the organising sub-committee of the Cyprus Research Centre which organised the

"Exhibition of Book and Photograph" which was opened by the Minister of Culture and Education, which was opened by the Minister of Culture and Education, Mrs C Angelidou, at the Famagusta Gate within the framework of the same conference.

- The Workshops in co-operation with the Institute of Electronics and Electrical Incorporated Engineers (IEEIE) Cyprus Development Group organised a short course of 24 hours duration on "Fire Alarm and Intruder Systems" between 2 and 21 November.

- Mr I Angeli, Laboratory Assistant, and Mr Tony Smith delivered a two-day short course on "Failure Mode and Effects Analysis" between 6-7 November. The course was organised by HTI and CMEA.

- HTI in collaboration with the Cyprus Chamber of Commerce and Industry organised a seminar on "Stereolighography, New Technology in the production of Prototype Moulds" which was held on the 22 of November.

- Mr C Theopemptou, Lecturer, participated in the European Youth Information and Counseling ERYICA General Meeting which took place in Bled, Slovenia during 22-26 of November.

- Dr. C Chrysostomou, Lecturer, participated as a lecturer in the Pancyprian Symposium "Government action plan for facing the chaos caused by a strong earthquake" that took place in Limassol on the 25-26 November 1995. The title of the lecture was "Presentation of the damages caused by the Paphos Earthquake to buildings and description of their response to the earthquake load".

- Mr C Neocleous, Lecturer, participated in the "International Conference on Neural Networks" and "International Conference on Evolutionary Computing" which were held in Perth of Australia from 26 November to 1 December. In these conferences he presented a research paper titled "Artificial Neural Networks in Marine Propeller Design".

- The Department of Electrical Engineering in collaboration with IEE Cyprus Centre and the Industrial Training Authority organised three short courses on: "Programming in Visual Basic", "Designing and Installing LANS" and "Supporting and using MS Windows" during 13-16/11/95, 20-23/11/95 and 28/11-1/12/95 respectively.

- The staff of HTI has been involved with local research programmes, which were approved in 1995, as well as research programs financed by the European Union. During the period between August and November, 15 proposals were made under the MED. TECNO, MED-CAMPUS and INCO (International Co-operation) Programs. Proposals have also been made within the framework of governmental co-operation with Greece on issues of Research and Technology.

DECEMBER

- The Cyprus Computer Society in association with the Higher Technical Institute organised a short course on "Software Testing Methods" from 5-8 December.

- Dr. D Serghides, Senior Lecturer, published an article on the "Prototype Solar House", an HTI project, in the December issue of the international solar magazine "Sun at Work in Europe".

JANUARY

- The Annual General Conference of IAESTE (International Association for the Exchange of Students for Technical Experience) was held in Copenhagen, Denmark, from 20-26 January. Fifty-seven (57) countries participated in the conference with one hundred and seventy-five (175) representatives. HTI was represented by the HTI Director, Mr D Lazarides Chairman, and Mr Ch. Chrysafiades, National Secretary of IAESTE Cyprus. The Cyprus delegation received 33 places for the summer training of HTI students and offered 28 places to students from various IAESTE member countries to receive training in Cyprus.

- The First Semester Examination were held between 17-30 January.

FEBRUARY

- Mr I Angeli, Laboratory Assistant, represented Cyprus in the 6th World Congress on Total Quality in Delhi, India, from 12-19 February. Mr Angeli presented a paper on "TQM diagnostic phase", a QM study for the Cyprus manufacturing industry.

- Mr S Savvides, Workshop Superrintendent, enrolled with the University of Glamorgan for the 2nd semester of the academic year 1995/96, in order to obtain an MBA degree. Mr Savvides was absent on leave as from 12 February.

- The Higher Technical Institute and the Cyprus Computer Society in collaboration with the Institution of Electrical Engineers, the Cyprus Professional Engineers Association, the Cyprus Association of Medical Physics and Biomedical Engineering and the Institution of Electronics and Electrical Incorporated Engineers organised a lecture on "Shape Reconstruction and Robotics" by Professor Jean-

Daniel Boissonnat on 15 February.

- The Cyprus Computer Society in association with the Higher Technical Institute organised a short course on "Network Planning Support Management" from 20-23 February.

- Mr S Avgousti, Instructor, attended a short course in "Advace Internet Services" from 27-29 February. Its total duration was 25 hours and the lectures were given by the Cyprus International Institute of Management.

MARCH

- Mr I Angeli, Laboratory Assistant, delivered a twenty-two hours short course on "Statistical Process Control" between 10-21 March. The course was organised by the HTI Mechanical Engineering Department.

- Ms D Charalambidou-Solomi, Lecturer, on invitation from the Cyprus University attended the "B' International Symposium on George Seferis" which was organised by the Cyprus University and the Municipality of Ayia Napa between 16-18 March.

- The HTI Director, Mr D Lazarides, within the framework of the HTI Exchange Visit Programme with tertiary education institutions, visited the Faculty of Engineering of the Suez Canal University at Ports-Said, Egypt between 18-21 March.

- HTI in collaboration with the Cyprus Computer Society organised a short course on "Structural Systems Analysis and Design Methodology - Part A". The course was held between 18-22 March and was delivered by Dr. Mike Goodland of Metadata , U.K.

- HTI suspended lectures for two periods in order to celebrate the two national days of 25 March and 1 April on Thursday, 21 March. The students delivered speeches, sang national songs and performed national dances.

- The HTI Director, Mr D Lazarides, on an invitation from the Community of Mediterranean Universities (C.M.U) attended its General Assembly which was held in Cairo, Egypt between 22-23 March.

- The Second Mid-Semester Examinations were held between 29 March-5 April.

APRIL

- HTI in co-operation with IEE-Cyprus Centre and the Industrial Training Authority organised a 24 hr course on "Programming in Visual Basic" which was held between 2-4 April. The course was presented by Mr Alan Freeman of Euromanagement of Technology Bureau, London.

MAY

- On Thursday, 2 May HTI staff and students donated blood for the needs of the Nicosia General Hospital Blood Bank.

- Ms Chr Antoniou, Senior Instructor, presented on 2 May the findings of her research on "Women Civil Engineers in Cyprus" within the framework of a seminar on women organised by the University of Cyprus.

- Mr Sp Spyrou, Senior Lecturer, participated in a meeting of the Technical Committee TC 62 of the European Standards Committee CENELEC held in Dublin, Ireland, between 6-7 May. The meeting discussed the adoption of standards relating to medical and hospital electrical equipment.

- HTI in co-operation with the Cyprus Computer Society organised a short course on "Computer Networks Architectures and Protocols". The course was held between 7-10 May and was delivered by Geoff Tagg of Learning Tree International Ltd.

- Dr. D Serghides, Senior Lecturer, participated in two seminars held in Athens between 9-10 May: "Bioclimatic Architecture - Laws and Regulations" and "Application of Intelligent Control Systems in Buildings" at the Central Institution for Energy Efficiency Education of the University of Athens.

- On Thursday May 16, HTI celebrated Sports Day by holding various athletic events. The main events were a walk through the Athalassa Forest in memory of the late Marios Pattichis, HTI Senior Lecturer, and friendly matches between HTI students and ELDYK basketball and football teams.

- The HTI Social Formal Dinner was held on Thursday 16 May at the Holiday Inn Hotel in Nicosia. The third year students dined with HTI members of staff and guests from the private and government sectors. The Minister, Mr Andreas Moushiouttas and the Director General, Mr N Symeonides, of the Ministry of Labour and Social Insurance honoured the dinner with their presence.

- HTI in co-operation with the Cyprus Computer Society organised a short course on "SSADM Part B" between 20-24 May. The course was delivered by Dr. Karel Riha of Metadata, U.K.

- Members of the academic staff of HTI involved in research attended a one-day seminar on "Information

Day on the EU Policy on Research and Technological Development" which was held on 23 May by the Planning Bureau at the International Conference Centre in Nicosia.

- HTI in co-operation with IEE - Cyprus Centre and the Industrial Training Authority organised a 20 hr course on "Interconnecting Unix, OS/2 Netware". The course was held between 27-29 May and was presented by Steve o' Donnell of the Euromanagement and Technology Bureau, London.

- Dr. M Ioannides, Lecturer, gave a lecture on "Stereolithography" to the members of the Cyprus Chamber of Commerce-Limassol Branch on 29 May.

JUNE

- HTI in co-operation with IEE - Cyprus Centre and the Industrial Training Authority organised a 25hr course on "Visual Basic for Applications". The course was held between 4-7 June and delivered by Mr Alan Freeman of the Euromanagement and Technology Bureau, London.

- Mr I Angeli, Laboratory Assistant, delivered a four day short course on "How to Use Teams to Improve Quality" between 5-11 June. The course was organised by HTI and CEA.

- The Second Semester Examinations were held between 7-21 June.

- HTI Director, Mr D Lazarides, was one of the speakers at the seminar: "George Stevenson Lecture" which was organised by the Cyprus Group of Civil and Mechnical Professional Engineers - Cyprus Branch at the Forum Intercontinental Hotel, Nicosia on Saturday 8 June under the auspices of the Minister of Labour and Social Insurance, Mr Andreas Moushiouttas. Mr Lazarides read a paper on "Tertiary Education Graduates and the Employment Market: The Role of the HTI in Training". The main speaker was Dr. A Denton, past president of the Institution of Mechanical Engineers (U.K.) who delivered the George Stevenson Lecture entitled: "The Role of Technical Education Training and the Engineering Profession in the Wealth Creating Process".

- Dr. M Ioannides, Lecturer, participated in the International Conference "Rapid Product Development 96" held in Stuttgard, Germany between 10-11 June and read a paper on "Reverse Engineering & Rapid Prototyping for Archaeology".

- HTI in co-operation with the Cyprus Computer Society organised a short course on "Introduction to Visual Basic" between 10-14 June. The course was delivered by Mr Richard Howells of Learning Tree International Ltd.

- Dr. D Serghides, Senior Lecturer, in her capacity as the President of the ISES - Cyprus, organised and addressed a seminar on "Solar Energy in Buildings" on 16 June.

- HTI in co-operation with IEE - Cyprus Centre and the Industrial Training Authourity organised a 25 hr course on "Supporting Windows 95". The course was held twice between 18-21 June and 25-28 June and was presented by Neal Hutchinson of the Euromanagement and Technology Bureau, London.

- Ms D Charalambidou - Solomi, Lecturer, gave a lecture on "Professional Written Communication" on 21 June to Palestinian Senior Civil Servants within the framework of the programme "General Management" organised by the Cyprus Productivity Centre in Nicosia between 20-21 June.

- Dr. M Ioannides, Lecturer, participated in the Conference on "The Information Society in the Eastern Mediterranean Countries" organised by the Cyprus Research Centre in Nicosia and read a paper on "The State of the Art in Stereolithography".

- Ms D Charalambidou - Solomi, Lecturer, served on the organising committee of the Cyprus Productivity Centre which in co - operation with the European Union, held a 3 - day Conference on "The Information Society in the Eastern mediterranean Countries" between 23-25 June.

- HTI in co-operation with the Cyprus Computer Society organised a short course on "Specifying and Managing User Requirements" between 25-28 June. It was delivered by Mr Mike Berry of Learning Tree International Ltd.

JULY

- The 1996 Graduation Ceremony was held on I July at the International Conference Centre in Nicosia. It was attended by the President of the Republic, Mr Glafcos Clerides the Minister of Labour and Social Insurance, Mr Andreas Moushiouttas, and the Director General, Mr Nicos Symeonides, diplomatic corps, other dignitaries and guests.

The Graduation Ball was held at the Cleopatra Hotel in Nicosia.

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από το όνειρο... στην πραγματικότητα

Η ΕΤΑΙΡΕΙΑ ΠΟΥ ΠΡΟΣΦΕΡΕΙ ΣΤΑ ΜΕΛΗ ΤΗΣ ΟΥΣΙΑΣΤΙΚΗ ΕΞΥΠΗΡΕΤΗΣΗ

1. Παραχωρούνται ΣΤΕΓΑΣΤΙΚΑ ΔΑΝΕΙΑ μέχρι £35.000,00. Το δάνειο αυξάνεται μέχρι τις £45.000,00 ανάλογα με το ύψος των αποταμιεύσεων.
2. Παραχωρούνται Δάνεια για αγορά οικιακού εξοπλισμού μέχρι £12.000.00.
3. Παραχωρούνται ΦΟΙΤΗΤΙΚΑ ΔΑΝΕΙΑ μέχρι £20.000,00 ανάλογα με το ύψος των αποταμιεύσεων από το ΕΙΔΙΚΟ ΤΑΜΕΙΟ ΣΠΟΥΔΩΝ το οποίο λειτουργεί από το 1981.
4. Δεχόμαστε καταθέσεις όλων των τύπων από μέλη και μη μέλη με πολύ ΕΥΝΟΙΚΟΥΣ ΟΡΟΥΣ.
5. Για καλύτερη εξυπηρέτηση των μελών άρχισε η λειτουργία του θεσμού των τρεχούμενων λογαριασμών.

ΣΥΝΕΡΓΑΤΙΚΗ ΟΙΚΟΔΟΜΙΚΗ ΕΤΑΙΡΕΙΑ ΔΗΜΟΣΙΩΝ ΥΠΑΛΛΗΛΩΝ ΚΥΠΡΟΥ ΛΤΔ.

ΤΗΛ. 442861 - ΛΕΥΚΩΣΙΑ ΦΑΧ: 368225