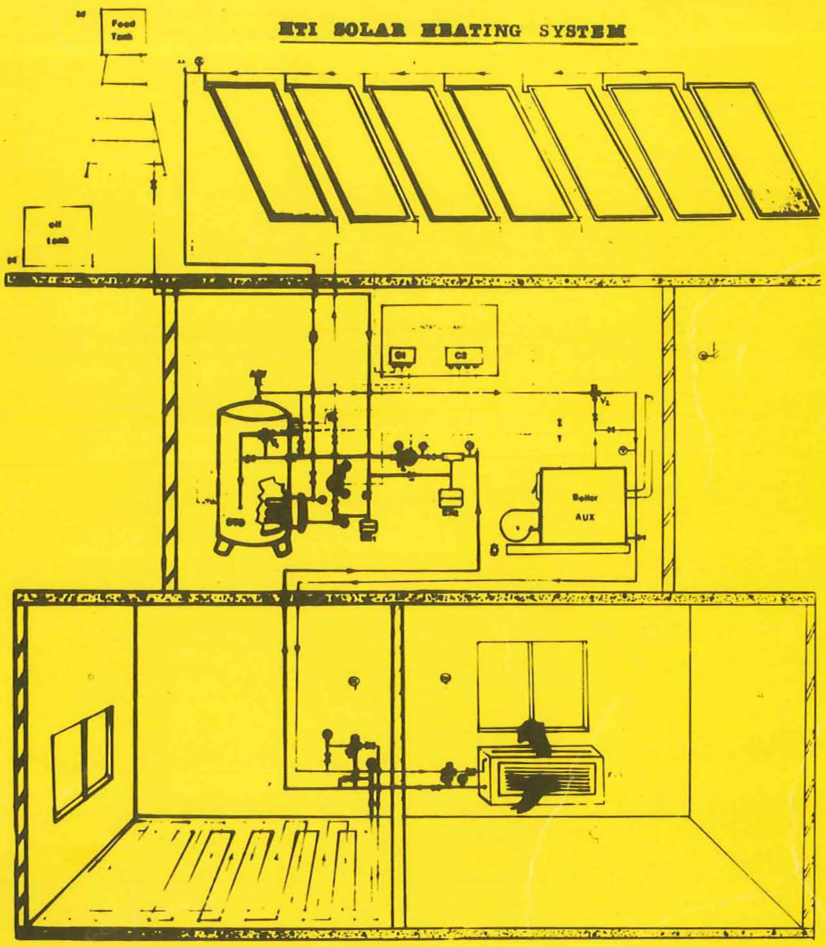
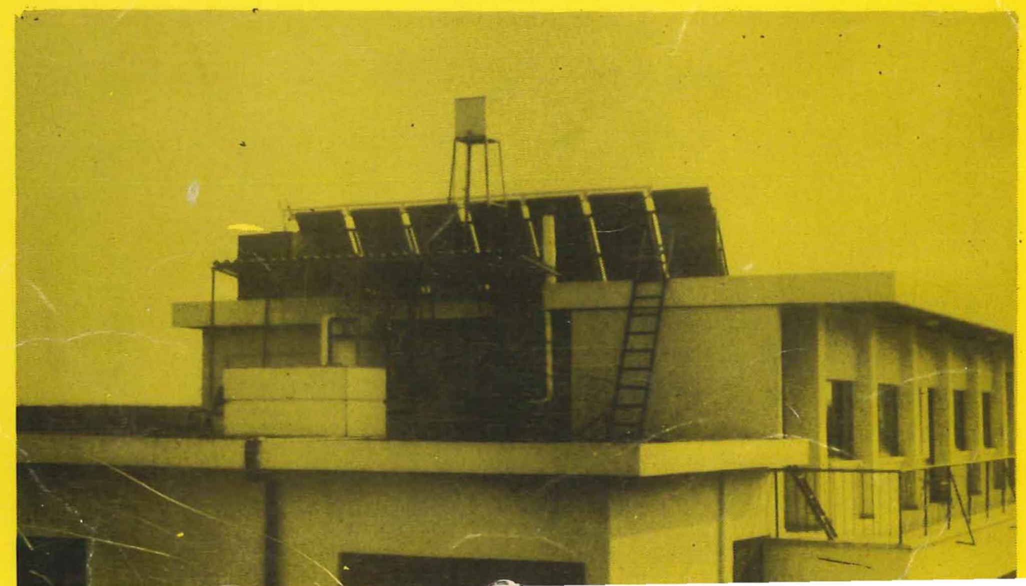
No. 14 June 1985 Nicosia

Review

THE HIGHER TECHNICAL INSTITUTE





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Experimental solar heating system, HTI

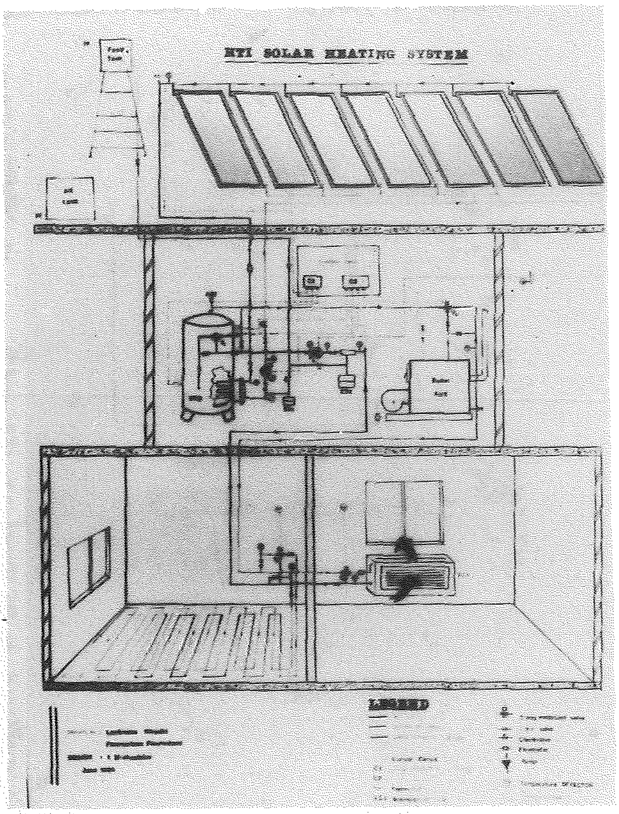

Photo by I. Agge

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The Higher Technical Institute (H T I) 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), and the International Labour Office (ILO). Cyprus Government Executing Agency: The Ministry of Labour and Social insurance.

Review

No. 14 June 1985 Nicosia

EDITORIAL

Challenge of the New Technology

Microelectronics and the microchip in particular were non-existent some 25 years ago. Now the microchip revolution is a reality and has engulfed us so rapidly that practically no activity in any engineering discipline, industry, manufacture, banking, medicine, household apparatus, e.t.c., will be deficient of the microchip Technology.

Traditional Training Skills and expertise are overtaken by the high technology and the big question facing all people concerned is, or should be, "Have I got the knowledge or am I equipped to participate in, or cope with this fast changing world of high Technologies that are with me now".

This is a burning question, especially for the Trainers who shoulder a great responsibility for shaping the manpower of the future, which has already been called the Technological Era. For most of us the future is already evident.

Unfortunately the answer to the question is NO for most people concerned and the resposnibility does not lie on the individual alone but is also shared by the Authorities, involved with Training including the industry and organisations concerned with man-power development and the acquisition of skills.

It goes without saying therefore that unless drastic measures are taken by Government and relevant Authorities including generous investments in staff up-grading schemes we shall fall back into misuse. It appears that doing a little more to what we used to for staff upgrading may not be enough. A complete new and determined thrust will be required. Imaginative plans and generous resource allocation are some of the prerequisites.

The Editorial Committee

Separate projections may be made for a number of main sectors eg. Transport, Domestic and Commercial, Industry and Agriculture.

Following a detailed "bottom up" approach an energy system may be disaggregated both with regard to fuels and several demand sectors each of which may be considered adequately homogeneous for separate representation in the model. A unified model of this type for an energy system of m sectors and n fuels may take the following form:

$$E_k(t) = \sum_{j=1}^{m} I_{kj}(t)\, Y_{jk}(t) \qquad K = 1,2 \ldots, n \qquad (8)$$

where E_k (t) is the total kth fuel requirement

$I_{kj}(t)$ is the kth fuel intensity in the jth sector

$Y_{jk}(t)$ is the activity level in the jth sector utilizing the kth fuel

Expanding for E_k (t+T) where T = 1 year it can be shown that

$$\Delta E_k(t) = \sum_{j=1}^{m} Y_{jk}(t)\, \delta I_{kj} + \sum_{j=1}^{m} I_{kj}(t)\, \delta Y_{jk} + \ldots \qquad (9)$$

In order to calculate incremental fuel requirements on a year to year basis it will be necessary to project δY_{jk} i.e. sectoral growth rates on a scenario basis ad construct suitable submodels to estimate δI_{kj} i.e. the change in intensity of the kth fuel in the jth sector, taking into account the various applicable mechanisms of change such as conservation, structural changes and fuel substitution.

It must e noted that the number of parameters used to characterize fuel substitution (refer also to equation (5)) usually rises as the square of the number of fuels so that disaggregation into many fuels leads to a situation in which the parameters are not well defined by time series data. Disaggregation into many sectors does not create this problem as long as time series data for each sector are available.

5. Conclusion

A good deal of consideration must be given to the particular characteristics of an energy system before the appropriate modelling methodology is adopted. Generally it may be supported that econometric modelling complemented by various enginnering concepts and starting at a judicious level of disaggregation may provide a good modelling framework in which fuel intensities in particular sectors can be estimated in consideration of applicable processes of change.

References:

1. (1981) Eden, R., et al.
Energy Economics
Cambridge University Press

2. (1980) Demetriades, E.I. and House, W.J.
The supply and demand for energy in Cy prus

3. (1974) Cherniavski. E.A
Brookhaven energy system optimization model
Brookhaven National Laboratory

4. (1980) Lomas, E.J.
UK energy modelling (Department of En— ergy)
Measurement and control Vol. 13

5. (1979) Fishbone. L.G.
MARKAL , a multiperiod linear programming model for energy system analysis.
Brookhaven National Laboratory

6. (1982) Samouilidis, J. and Ladia, A.
A model for the Greek energy system
European Journal of Operational Research

7. (1983) Ormerod, R. and McLeod, J.
The development and use of the NCB strategic model
Energy Statistics Conference, Cambridge

8. (1980) Bending, R.
A revised simulation model of UK industrial energy use
University of Cambridge

9. (1981) Skea, J.F.
Modelling coal penetration in the industrial steam raising markets
University of Cambridge

10. (1985) Drakos, T.
Distributed energy modelling for inverstment planning in the Republic of Cyprus
HTI Nicosia (PhD Thesis)

Research

PERFORMANCE OF THE HTI EXPERIMENTAL SOLAR HEATING SYSTEM

by I. M. Michaelides, BSc, DUES (France), CEng MInstE
Senior Lecturer HTI.

Abstract

The HTI Experimental Solar Space Heating System became operational in March, 1984. During the first months of operation the emphasis was placed on adjustment and fault corrections. Following this initial commissioning and check out period, performance testing and evaluation commenced.

The technical characteristics of the system were presented in the HTI Review No. 13 in June 1984.

This paper aims to discuss the performance tests carried out during the heating period of November 1984 to March 1985 and evaluate the results obtained.

Introduction

In 1982, the Government allocated a budget for initiating a research project in solar space heating at the Higher Technical Institute.

The principal objective of this project was to design and install an experimental Solar Space Heating System for the purpose of:

(i) finding out whether solar energy could be efficiently utilised for space heating in Cyprus and

(ii) use the experimental intallation as a demonstration unit for interested people from industry.

The above installation was completed in March, 1984, and all commissioning tests were carried out during that period.

The system was put in full operation in November, 1984, to meet the heat requirements of two office rooms, hereinafter called "room A" and "room B", at the HTI. The heat emision in room A was done by means of floor heating while room B was heated by a fan coil unit.

A number of performance tests were carried out during the heating season of 1984-85 (November 1984 to March 1985), the finding of which are presented and analysed in this report.

PERFORMANCE TESTS

1. General

Room space heating was required for 5 working days per week (Monday to Friday) from 7.30 a.m. to 2.00 p.m. Based on the results obtained during the commissioning tests, carried out at the beginning of 1984, which showed that the thermal response of the heated floor in Room A was very slow, the system was programmed to operate from 1.00 a.m. to 1.00 p.m. every working day, except from Wednesdays where it operated till 5.00 p.m.

A number of tests were carried out, each one aiming to a particular objective, as follows:

Test No.1. Determination of the Specific Heat Loss Coefficient, G, of the heated spaces

Test No.2. Determination of the Efficiency of Solar Collectors

Test No.3. System performance Tests (with and without auxiliary energy source).

Details about the objectives of each series of tests are given in th presentation of the results and conclusions which follow.

2. Test No. 1 Determination of "G" values

The "G" value, defined at the Specific Heat Loss Coefficient of a building, is a thermal characteristic and is thus an indication of the degree of thermal insulation of the building. It is very useful in calculating the building head requirements for a certain period of time, i.e.

$$Q = G \times V \times Dd \times n/1000$$

where Q = Building heat requirements for a period of time (kW)

V = volume of heated space (m^3)

Dd= Number of Degree-days corresponding to the above period of time

n = Number of hours of heating per day

G = Specific heat loss coefficient ($W/m^3\,^0C$)

Three test were carried out at different dates; the readings and the results are tabulated in Table 2.1

As it is seen from the results, the calculated "G" value for the room under test is very high (3.42 — 3.52 $W/m^3\,^0C$) as compared to international standards. In France, for example, which is divided into three climatic zones according to predominant weather conditions, the recommended "G" values vary from 1.2 $W/m^3\,^0C$ for cold zones to 1.35 $W/m^3\,^0C$ for warmer zones (Southern France, Mediterranean areas)

For Cyprus where the weather conditions are not as severe as in southern France, a value of about 1.5 $W/m^3\,^0C$ might be suitable, but not 3.5 $W/m^3\,^0C$!

That is an indication of very poor insulation and thus increased heat losses. As a result of this, the radiating floor in room A might be proved inadequate to satisfy the room heat requirements.

Table 2.1 "G" Value

Test No.	Date	* t_a (°C)	t_A (°C)	t_B (°C)	* Wind speed (m/s)	* Ih (W/m²)	Q (kW)	G W/m³ °C
1.1	20/2/85	12.9	18.5	21.0	8.1	728	2.479	3.46
1.2	21/2/85	5.5	15.5	21.0	4.6	626	4.546	3.42
1.3	22/2/85	6.5	15.5	21.0	1.8	360	4.304	3.52

* Average values

t_a = ambient air temperature (°C)

t_A = temperature in Room A (°C)

t_B = temperature in Room B (°C)

Ih = solar radiation intensity on a horizontal plane (W/m²)

Q = rate of heat supplied by the boiler (kW) at steady state conditions

$$G = \frac{1000 \times Q}{V_A (t_A - t_a) + V_B (t_B - t_a)} \quad W/m^3 \,^0C$$

V_A and V_B in m^3 represent the space volumes in room A and B respectively.

Note: For the calculation of Q, the boiler efficiency was found experimentally to be equal to 77% (low, due to operating the boiler at low temperatures)

Taking into consideration the fact that the majority of residential buildings in Cyprus have their construction similar to that of the HTI experimental rooms, it would be wise if prior to any solar application in space heating, the thermal characteristics of the building are improved so that the G value is kept down to reasonable values, otherwise solar energy utilisation cannot be competitive.

3. Test No.2 Solar Collector Performance

The object of this investigation was to evaluate the performance characteristics of the solar collector array (7 panels connected in parallel) and thus derive the characteristic equation for the collector efficiency. For this purpose, the following data should be recorded:

- collector inlet temperature, tc_i (°C)
- collector outlet temperature, t_{co} (°C)
- solar radiation intensity, I (W/m²)
- water flow rate, m (kg/s)

The collector charactristic equation is of the form

$$n = A - B\,(\Delta T/I)$$

where n = collector efficiency

A, B = constants, characteristic of the collector

$$\Delta T = \frac{tci + tco}{2} - (t_a - 3) \ ^0C$$

t_a = ambient air temperature, (°C)

I = solar radiation intensity, (W/m²)

Similar work has been carried out early in 1984; the data collected at that time was fed in the computer which produced the performance characteristics illustrated in Fig. 3.1. This figure shows the efficiency of the collector array with relation to ΔT/I, i.e.

$$\text{Efficiency} \quad n = 0.6287 - 7.4487\,(\Delta T/I)$$

The characteristic equation for the single panel (based on tests conducted by the Ministry of Commerce and Industry in 1982) was found to be:

$$n = 0.70 - 6.504\,(\Delta T/I)$$

In figure 3.1, Y represents the efficiency, n, and X represents the ratio ΔT/I.

It can be seen from this graph that the curve plotted for the collector array of seven panels installed at the HTI lies below the one plotted for the single panel especially at increased ΔT/I. This means that the efficiency (Y-coordinate) of a group of panels connected together is smaller than the efficiency of a single panel because of increased heat losses in the former case from pipe connections.

A number of tests were carried out early in 1985 in order to check for the validity of the efficiency curves plotted in 1984. It was found that the collector efficiency follows the characteristic curve plotted for the array of 7 panels.

ΔT/I		efficiency, η		
	array		1 panel	
X= 0.00000	Y=	0.62870	Y=	0.70000
X= 0.00133	Y=	0.61877	Y=	0.69133
X= 0.00267	Y=	0.60884	Y=	0.68266
X= 0.00400	Y=	0.59891	Y=	0.67398
X= 0.00533	Y=	0.58897	Y=	0.66531
X= 0.00667	Y=	0.57904	Y=	0.65664
X= 0.00800	Y=	0.56911	Y=	0.64797
X= 0.00933	Y=	0.55918	Y=	0.63930
X= 0.01067	Y=	0.54925	Y=	0.63062
X= 0.01200	Y=	0.53932	Y=	0.62195
X= 0.01333	Y=	0.52938	Y=	0.61328
X= 0.01467	Y=	0.51945	Y=	0.60461
X= 0.01600	Y=	0.50952	Y=	0.59594
X= 0.01733	Y=	0.49959	Y=	0.58726
X= 0.01867	Y=	0.48966	Y=	0.57859
X= 0.02000	Y=	0.47973	Y=	0.56992
X= 0.02133	Y=	0.46979	Y=	0.56125
X= 0.02267	Y=	0.45986	Y=	0.55258
X= 0.02400	Y=	0.44993	Y=	0.54390
X= 0.02533	Y=	0.44000	Y=	0.53523
X= 0.02667	Y=	0.43007	Y=	0.52656
X= 0.02800	Y=	0.42014	Y=	0.51789
X= 0.02933	Y=	0.41020	Y=	0.50922
X= 0.03067	Y=	0.40027	Y=	0.50054
X= 0.03200	Y=	0.39034	Y=	0.49187
X= 0.03333	Y=	0.38041	Y=	0.48320
X= 0.03467	Y=	0.37048	Y=	0.47453
X= 0.03600	Y=	0.36055	Y=	0.46586
X= 0.03733	Y=	0.35062	Y=	0.45718
X= 0.03867	Y=	0.34068	Y=	0.44851
X= 0.04000	Y=	0.33075	Y=	0.43984
X= 0.04133	Y=	0.32082	Y=	0.43117
X= 0.04267	Y=	0.31089	Y=	0.42250
X= 0.04400	Y=	0.30096	Y=	0.41382
X= 0.04533	Y=	0.29103	Y=	0.40515
X= 0.04667	Y=	0.28109	Y=	0.39648
X= 0.04800	Y=	0.27116	Y=	0.38781
X= 0.04933	Y=	0.26123	Y=	0.37914
X= 0.05067	Y=	0.25130	Y=	0.37046
X= 0.05200	Y=	0.24137	Y=	0.36179
X= 0.05333	Y=	0.23144	Y=	0.35312
X= 0.05467	Y=	0.22150	Y=	0.34445
X= 0.05600	Y=	0.21157	Y=	0.33578
X= 0.05733	Y=	0.20164	Y=	0.32710
X= 0.05867	Y=	0.19171	Y=	0.31843
X= 0.06000	Y=	0.18178	Y=	0.30976

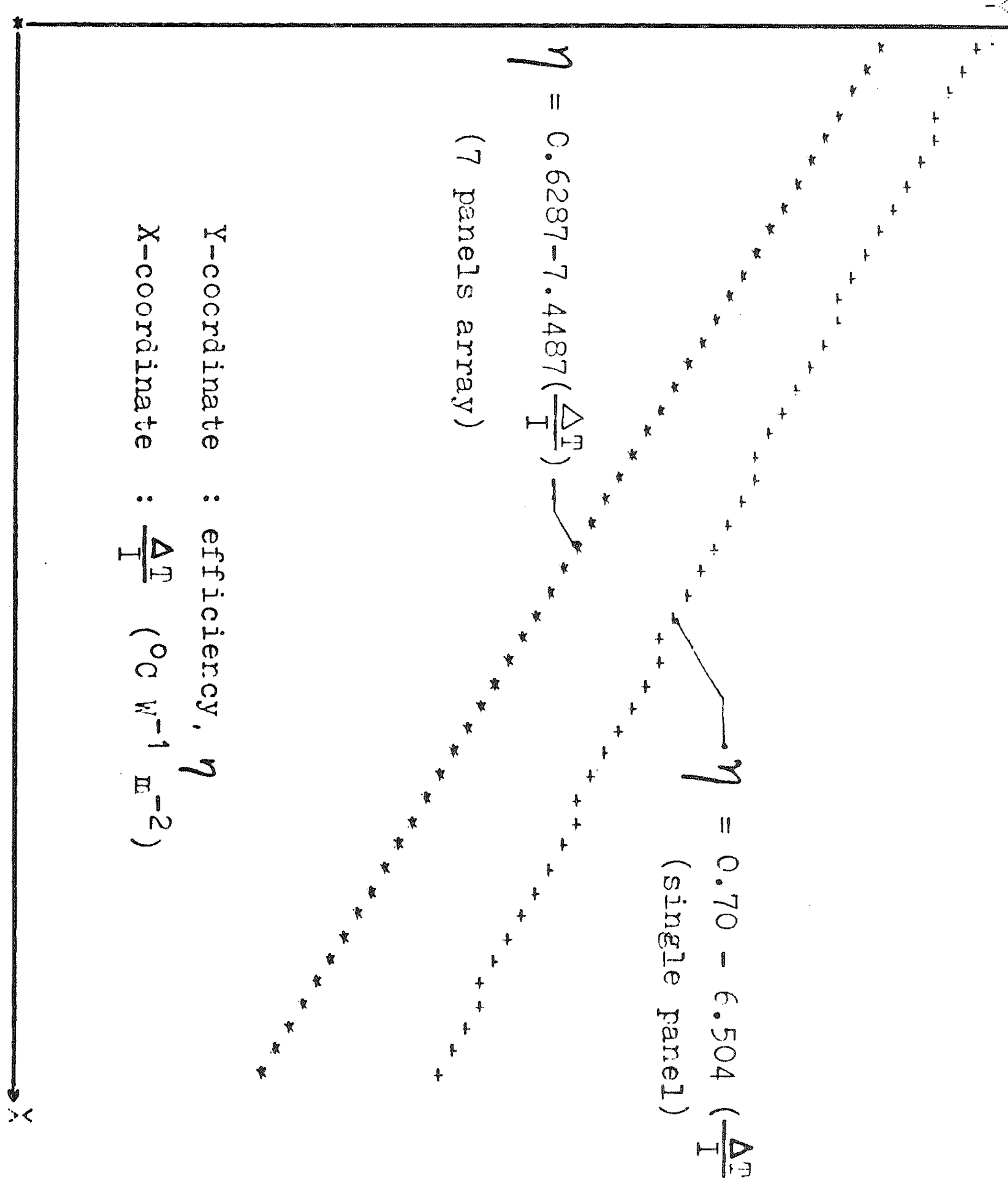


Fig. 3.1 Collector efficiency η, Vs $\left(\frac{\Delta T}{I}\right)$.

4. Test No.3 System Performance Tests

This was the major part of the project and comprised a number of investigations. The system was tested for its performance with and without the auxiliary source of energy (boiler). In particular, the objectives of this series of investigations were:

(i) To compare the degree of comfort achieved in each room and identify the problems, if any, associated with each method of heat emission in the rooms, namely the floor heating and the fan-coil-unit.

(ii) To investigate the system performance and percentage solar contribution, when operated with the assistance of the auxiliary boiler.

(iii) To investigate the system performance and percentage solar contribution, when operated without the assistance of the auxiliary boiler.

(iv) To identify the optimum operating conditions for the system.

4.1 System Performance with the auxiliary boiler in operation

The system was operating with the assistance of the auxiliary. The graphs illustrated in Fig. 4.1 show the variation of the temperatures in rooms A and B during the test period of 22/2/85 to 1/3/85; superimposed to the above is also a graph showing the variation of the ambient air temperature for the same period.

The temperature of the flow water in the heat distribution circuit was kept constant at 50^{0}C. As mentioned before, the system was programmed to operate from 1.00 a.m. to 1.00 p.m. on working days in order to compensate for the very slow thermal response experienced with the floor heating in room A. However, the fan coil unit in room B was programmed to start at 6.00 a.m. (faster thermal response).

From the flow meter readings recorded and the graphs of Fig. 4.1, the following points may be observed and discussed:

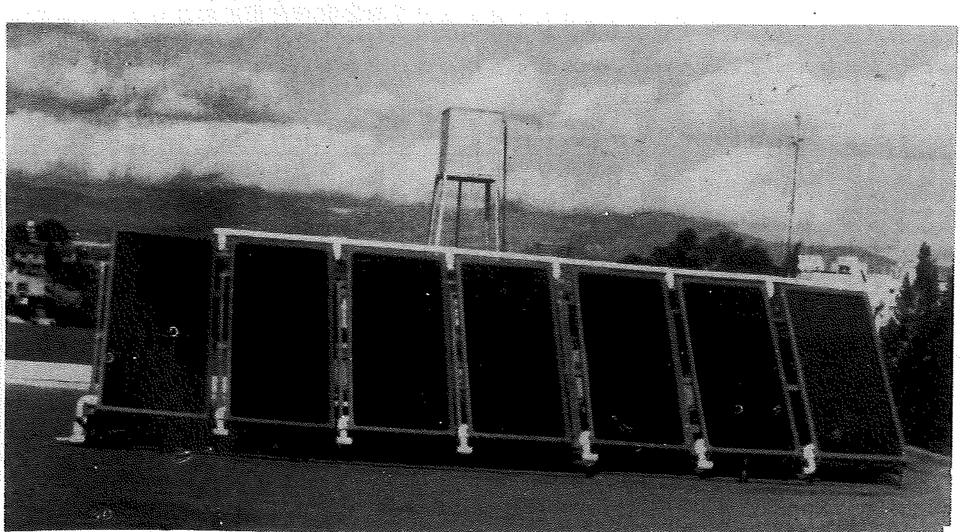
(i) The water flow and thus heat flow in room A (floor heating) was greated than that measured in room B.

(ii) In spite of the fact that the water flow temperature was the same in both cases and the water flow rate was greater in room A, the room air temperatures in room B varied from 18 to 21^{0}C, as compared to 13—18 ^{0}C, recorded for room A. The above temperatures correspond to the working hours i.e. 8.00 a.m. to 2.00 p.m. Lower air temperature in floor heated rooms does not necessarily mean lower degree of comfort. Floor heating is generally accepted as providing a very high standard of comfort as compared to other methods of heat emission mainly due to the fact that occupants are in direct contact with the heated (thus warm) floor and the low level of the room (area of action of occupants) is kept warm. However, things are better with room temperatures higher than 15^{0}C, even with heated floor. The reason for which in the tests presented the temperature recorded were so low is the high "G" value of the room. This makes the radiation surface (floor) too small and inadequate to satisfy the heat requirements of the room. The addition of longer floor piping and the increase of water temperature are not suggested because these will bring about higher costs and lower the solar contribution respectively.

(iii) The daily lowest room temperature recorded was 8^{0}C in room B.

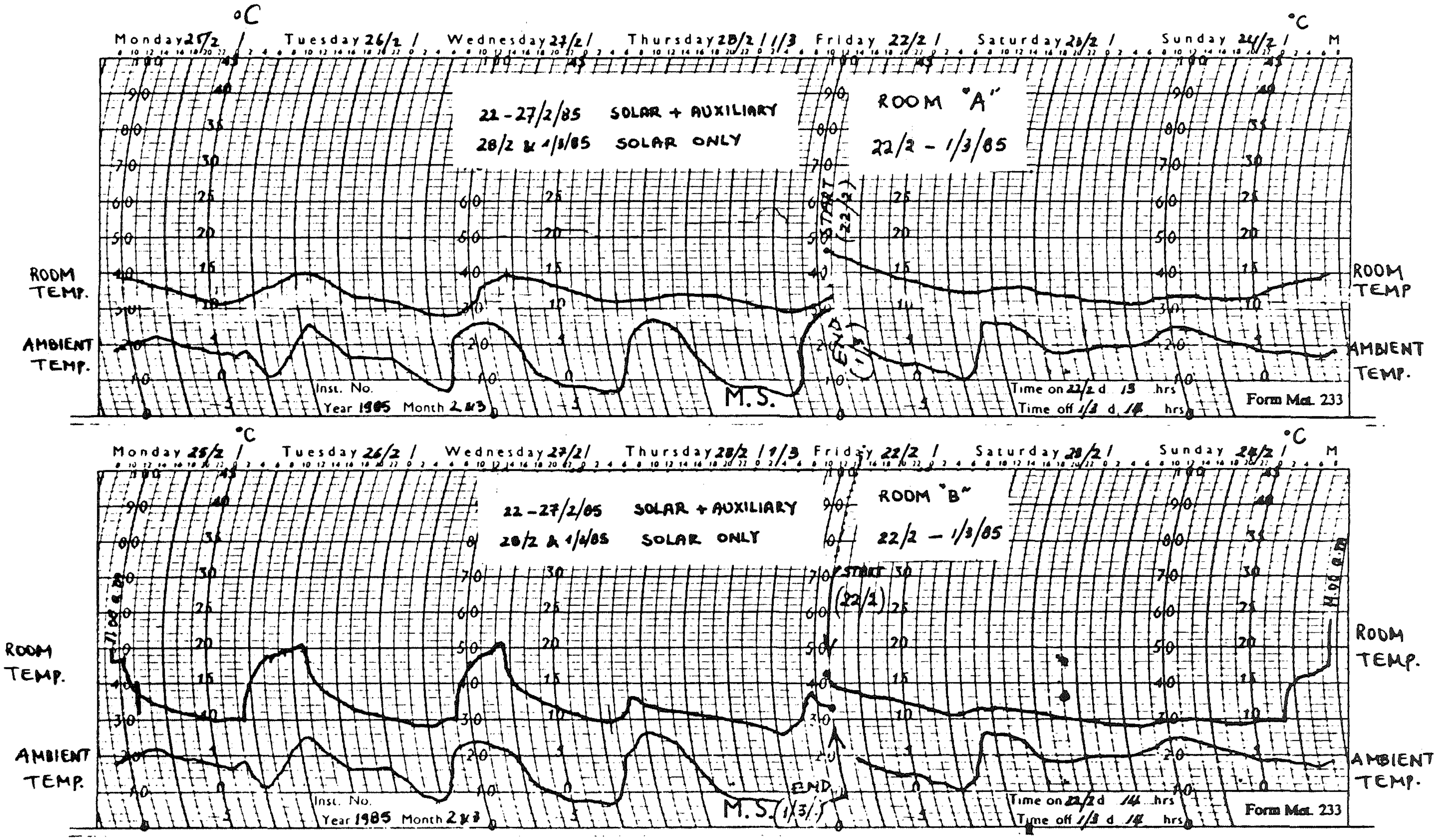
(iv) The variation of temperature is gradual in room A and quick in room B. For example, in room A the temperature dropped from max. 15^{0}C at 5 p.m. 27/2/85 down to a min. 11^{0}C at 8.00 a.m. 28/2/85 while in room B for the same period the temperature dropped from 20.5^{0}C to 9.5^{0}C. This is due to the increased thermal capacity of the floor heated room.

However, the situation is more or less the same as far as the minimum temperature is concerned in all other days where the system is put out of operation at 2.00 p.m.; in this case due to the long time interval between the STOP and next START (18 hours), the heat stored in the floor is gradually lost. Therefore, for intermittent heating systems it seems that floor heating is not the appropriate method of heat emission in the room.



A view of the solar panels on the roof.

Fig. 4.1. Variation of room and ambient air temperature (22/2/85 – 1/3/1985).



(v) The percentage solar contribution to the room heating for the above test period was not in fact considerable due to the fact that the temperature of the flow water was high (50^{0}C) resulting to a return temperature of 45^{0}C which was relatively high as compared to the storage tank temperature which very rarely reached temperatures higher than 45^{0}C. It has not been possible to calculate the solar contribution but from estimates it could not be higher than 20%.

4.2 System Performance without auxiliary

The auxiliary boiler was stopped for the test period 1/3/85 to 8/3/85 and the system was relying fully on solar energy stored in the storage tank of the system. The working water temperatures during that period varied from 45^{0}C to 30^{0}C.

The variation of air temperature in rooms A and B separately is illustrated in the graphs of Fig. 4.2. Superimposed to the above is also the graph representing the variation of the ambient air temperature for the same period.

From the graphs plotted and the other data recorded the following points may be observed and discussed:

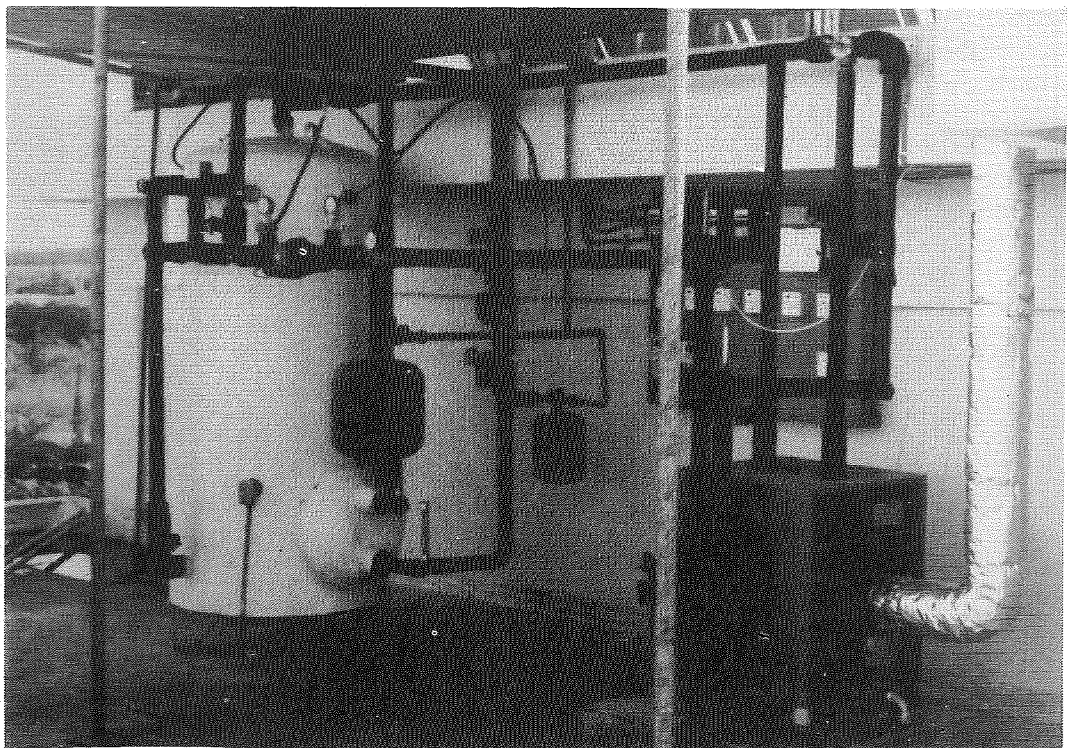
(i) The minimum room temperatures recorded were 7^{0}C in room A and 8^{0}C in room B when the ambient air temperature was —1.5^{0}C, during night time when the system was not in operation.

(ii) In room A, the temperatures recorded (max. 18—21 ^{0}C) were high enough to provide for a comfortable environment, but occured at the last 2—4 hours of the working day (12.00 noon — 3.00 p.m.); this is definitely due to the slow thermal response of the floor structure at low water flow temperatures. Nevertheless, what is important to note here, is that in spite of the fact that the system was not in continuous operation but intermittent, the room temperature change was small and slow as compared to the ambient temperature variation which was large and fast. In fact, the room temperature for the period of Monday to Friday never fell below 11^{0}C while the ambient air temperature dropped down to 2.5^{0}C.

(iii) For room B things are better. The room temperature for the period of Monday to Friday never fell below 12^{0}C. During the working period (8.00 a.m. to 2.00 p.m.) the room temperature varied from 18 to 22^{0}C which is within the design condition.

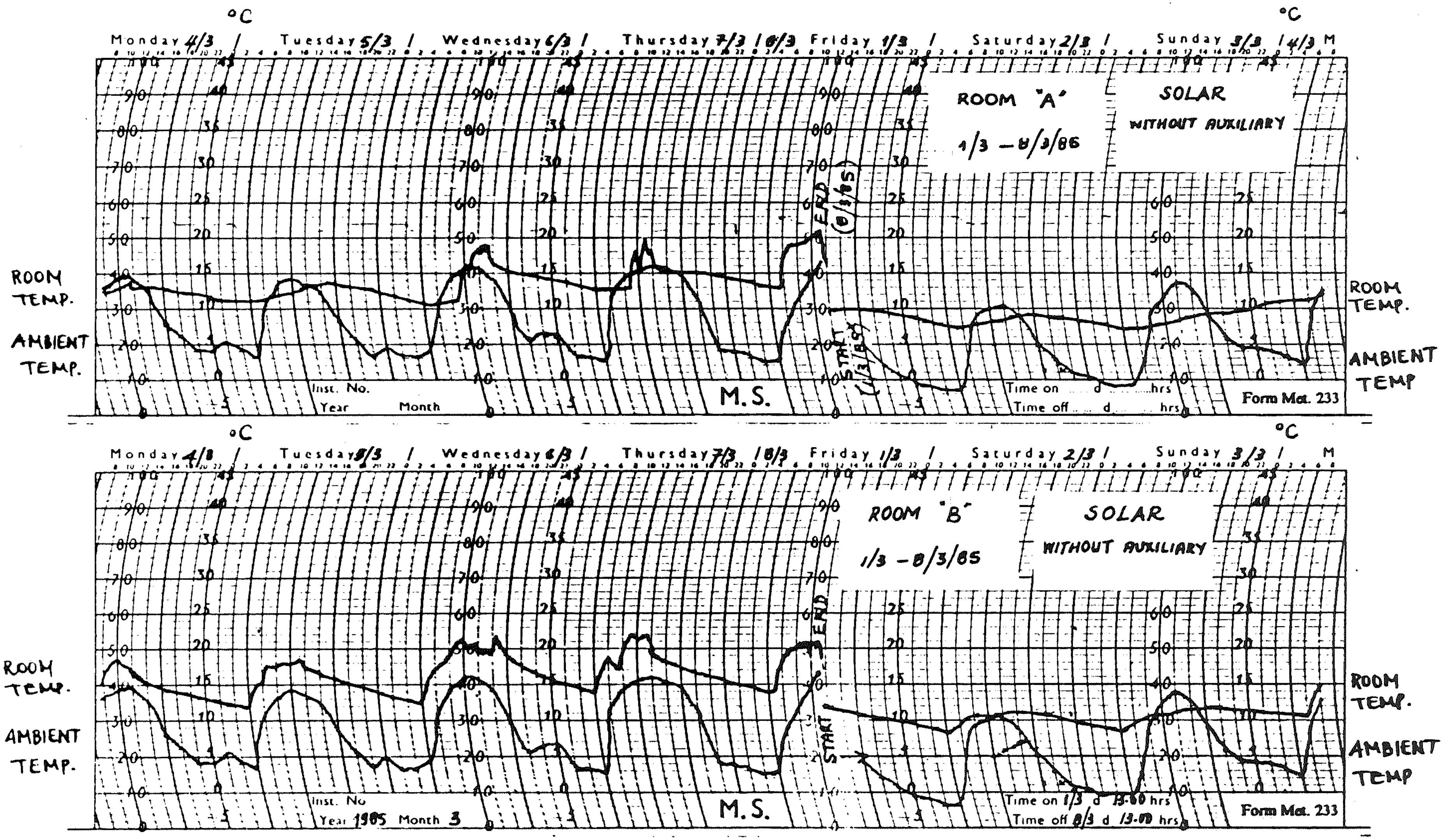
(iv) Comparing between room A and room B we can see that the temperature change in room B is both faster and greater than in room A. This is a disadvantage for room B.

(v) **The percentage Solar contribution** to the room heating demand for the above test period was proved to be close to 100%, i.e. the heating requirements were met fully by low temperature solar energy. Of course, this period of the time is not representative of heavy winter conditions and that is why the above statement cannot be generalised for the whole season.



A view of the plant-room.

Fig. 4.2. Variation of room and ambient air temperature (1/3/85 – 8/3/1985)



CONCLUSIONS AND RECOMMENDATIONS

1. It has been found that the fan coil unit in room "B" could operate efficiently and satisfy the room heat requirement even with low water temperatures (35—45^{0}C) as compared to the floor heating (room A) which needed a relatively long period of time to privide for comfortable conditions in the room.

2. In room A (floor heating) an even distribution of temperature was experienced and the temperature rises and falls were slow and gradual. Room air temperatures in the region of 16—18^{0}C proved to be satisfactory for comfortable condition in the room. On the contrary, the comfort in room B (heated by the fan convector) was not as good as in room A as a result of temperature gradients in the room; higher temperatures around the fan convector, lower temperatures near the floor and air draughts in the room. Dense temperature fluctuations of 2—3^{0}C also occured due to ON-OFF operation of the fan coil unit. The environment was comfortable with room temperature from 19 to 21^{0}C.

3. The percentage solar contribution to the space heating demand was very high (90—100%) during the period of March and November, when the ambient air temperatures were around 12—15^{0}C (mild winter) and with water flow temperatures of about 40^{0}C. Under these conditions the heating requirements could be satisfied fully without or with very little auxiliary energy supply.

4. For ambient air temperatures lower than 12^{0}C solar heating can be effective if boosted by the auxiliary boiler, provided that the water flow temperature does not exceed 40—45^{0}C. However, with floor heating and intermittent operation, this didn't prove correct and in fact with low water temperatures the heated floor could not satisfy the heating requirements of the room for the following possible reasons:

   (i) Very high room specific heat loss coefficient, G, (3.45 W/m$^{3\,0}$C as compared to International standards of 1.35 W/m$^{3\,0}$C). As a result of this the radiating surface (floor) was perhaps insufficient to satisfy the heat requirements of the room. Possible increase of pipe length could bring about higher costs. The problem will be solved by simply improving the lagging efficiency of the rooms and thus bringing the G value down to a reasonable value of not more than 1.5 W/m$^{3\,0}$C.

   (ii) Low heat transfer efficiency between the floor piping and the floor structure. The floor structure (pipe length, floor insulation etc.) has been designed based on a theoretical G value of 2.87 W/m^3 ^{0}C.

5. It has not been possible to investigate the percentage solar contribution for the whole heating season (Nov. 1984 — March 1985) due to unexpected faults in the data acquisition system; but based on the data collected for the oil consumption and the water temperatures recorded in the storage tank during that period we may say that the overall solar contribution for the test period, Nov. 1984 to March 1985, was about 30% (approximately 90% for November and March and about 20% for the other months). The low percentage estimated for the months of December, January and February is mainly due to the fact that for most of the time, especially with low ambient air temperatures, the system was set to operate at relatively high water temperatures (50^{0}C—42^{0}C), while in the storage tank the water temperature rarely reached 45^{0}C. As a result of this, the water returning from the rooms very rarely was going through the storage tank and thus the utilisation of the solar heated water was very little.

   However, assuming a reasonable G value of about 1.5 W/m$^{3\,0}$C and working with water flow temperatures of about 40—45^{0}C the percentage solar contribution to the heating demand of the above rooms could be 80—90% in November and March and 60—70% for the period of December to February. This could bring about an overall solar contribution of not less than 70%. This figure could bring about a considerable saving in fuel consumption.

6. The collection of solar energy was found to be most efficient when operating with a temperature differential (difference between the collector outlet and the storage water temperatures) of 8 K.

   This difference is justified for the following reasons:

   (i) the heat lost in the pipes from the collector to the storage tank (small length): 1 K

   (ii) the tolerances of the detector and the controller: 1 K

   (iii) the minimum temperature difference at the heat exchanger must not be less than 3 K for an effective heat transfer

   (iv) the collection system must only be put into operation when more useful energy is produced than the amount of energy required by the circulating pump, the minimum temperature difference being 3 K.

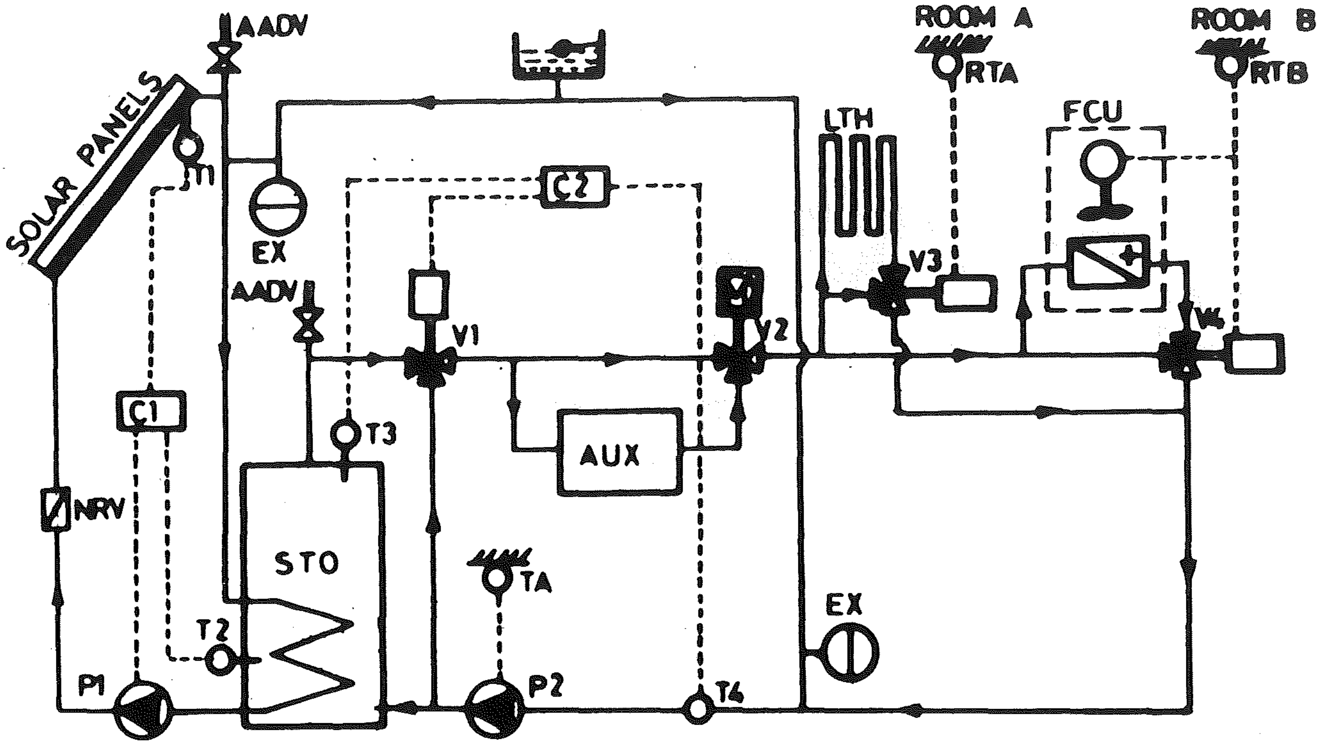
7. The HTI Experimental Solar Heating System can be used for demonstration purposes to interested people from industry. In addition to the actual installation offered for visits and demonstrations, the following teaching aids, prepared for this project, could serve towards the above purpose:

   (i) Coloured diapositives (photographs and slides) showing details of the actual installation. Such diapositives include details of the floor construction in the floor heated room, details of connections in the hydraulic circuit etc.

   (ii) As fitted drawings of the system showing all details of connections, controls and instrumentation.

   (iii) A coloured representation of the system layout, on perspex plate size 90cm × 65cm.

The system presentation/demonstration should be performed to organised groups from industry such as the Association of Manufacturers of Solar Collectors who have donated the 7 solar panels of the project, and other professional groups such as mechanical consultants and contractors, architects and engineers.



Schematic diagram of the HTI experimental solar heating system

STO	: Storage tank
AUX	: Auxiliary heat source (hot water boiler)
P1, P2	: Circulating pumps
C1, C2	: Temperature differential controllers
RTA, RTB	: Room Thermostats
EX	: Closed expansion tank
V1,V3,V4	: 3-way motorised valves ON-OFF
V2	: 3-way mixing valve (optional)
T1,T2,T3,T4	: Temperature detectors
TA	: Ambient temperature detector
AADV	: Automatic air discharge valve
NRV	: Non return valve
LTH	: Low temperature heating (floor)
F.C.U.	: Fan-coil unit

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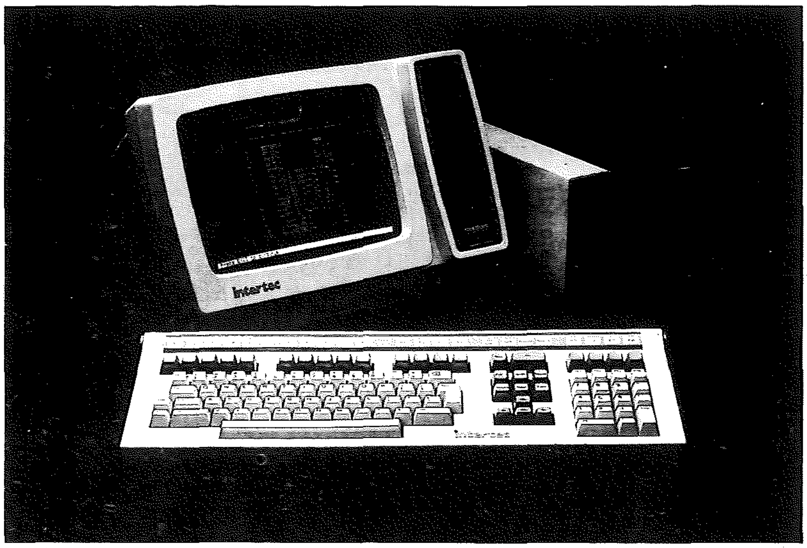

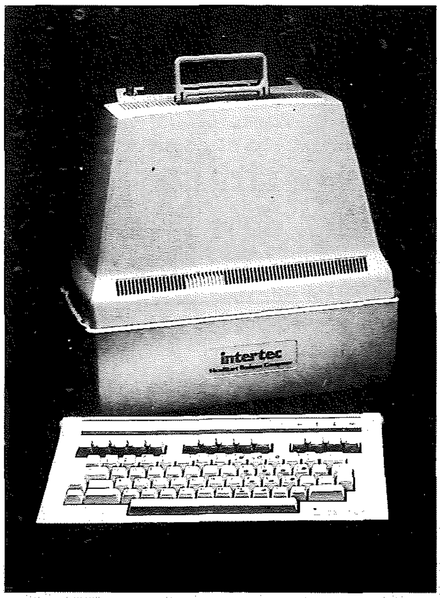

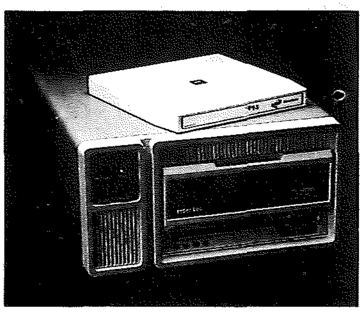

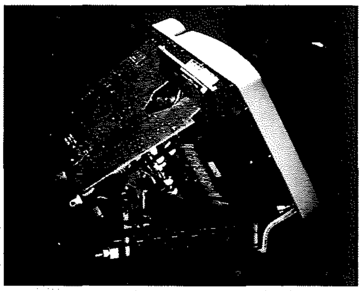

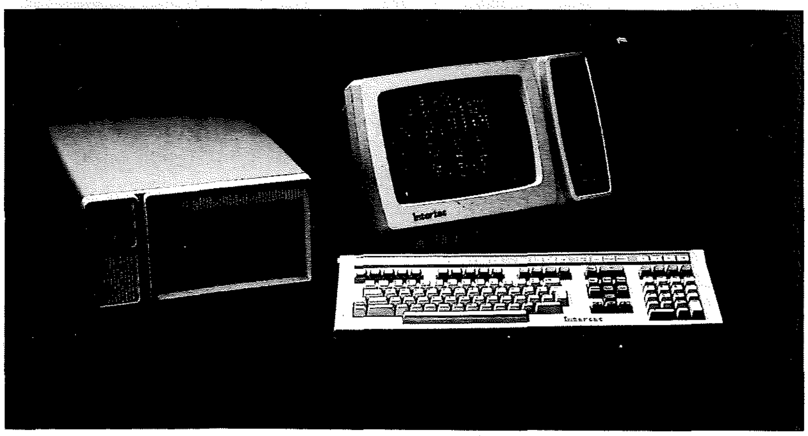

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THE DEVELOPMENT OF A NEW CLASSIFICATION SYSTEM FOR THE DUCTWORK INDUSTRY

by Dr. S. Constantinou

S. Constantinou — BSc, MSc, PhD, CEng., FIProdE., received his basic engineering training at the Higher Technical Institute in Cyprus and was then awarded a first class honours BSc degree in Engineering from the Middlesex Polytechnic in U.K.

Subsequently he was appointed as a production Engineer with H. Hargreaves and Son Ltd., in Manchester U.K. and he joined the Hargreaves / UNIST team concerned with the installation of an advanced CAD/CAM system.

In 1978, he received a Masters Degree for his work on that project and then he worked for a Doctorate in association with the company on the design and implementation aspects of CAD systems and new technology in manufacturing industry with particular emphasis on middle size companies. In 1980, he was awarded his Doctorate Degree.

After two years as the General Manager of Dermaplast Industries, Nicosia, he is now the Manager of Cassandra Trading Limited, Nicosia.

INTRODUCTION

Prior to considering what design criteria and parameters might be used in setting up a classification system, the question... 'why classify?'... should first be answered.

Classification is an information retrieval device which enables:

★ Rationalisation and standardisation of components to occur, with a corresponding reduction in component variety.
★ Existing designs to be utilised... thus avoiding further design effort.
★ Existing proven experience to be extensively used.
★ Existing costing figures to be either directly utilised or easily adjusted.
★ The advantages ensuing from the principle of economies of scale to be achieved.
★ The design of cost effective assemblies to occur by utilising cost effective components.
★ A simplification of the design, manufacture and costing processes to take place.
★ A firm to maximuse the utilisation of facilities by proving sales forecasting figures... especially for spare parts.
★ A firm to have a better knowledge of stock items currently available, and their properties, in a systematic way.
★ Improved communication between departments to take place.
★ To readily train new engineers in the company's procedures.
★ To fully utilise the capabilities of computers for data processing and retrieval.

The above list is an answer to the question... 'why classify?'... and it has not been exhausted. Within the factors given above, specific advantages could be stated which relate to functions and departments such as... Design, Production Control, Manufacture, Storage, Sales, After Sales Service, Marketing, Management Accountancy etc.

Every company, and certainly every departmen, looks upon a classification system from different viewpoint, depending on its priorities and requirements. Logically this leads to a second question... 'should a classification system be universal?' i.e. to cover all companies and every function within a company's operation... OR... should it be tailored and department orietnated, i.e. to cover the specific needs of a particular department?

Since the early 60's, under the powerful influence of (a) Group Technology and (b) workpiece statistics for machine tool design classification controversies have lead to the emergence of two basic 'schools of thought', see Figure 1, which corresponds to the two legs of the question asked above.

The first school advocates that a classification system should be universal and thus be applicable to every department within a firm and to every company within a specific industrial sector (1, 2). The second school suggests that every company is unique and each department within a firm has different functions, priorities and modes of operation, which indicates that tailored departmental classification systems are required (3, 4). The two most widely used systems are (i) Design Orientated (D.O.) and (ii) Manufacture Orientated (M.O.). Both systems, shown in Figure 1 claim successful implementation in industrial companies (2, 5).

1.1 UNIVERSAL SYSTEMS

The structure of a universal classification system should not be a function of a particular company or department but should be developed to cover a specific industrial sector and information should be interchangeable without difficulty between various companies (4)

1.2 DESIGN ORIENTATED SYSTEMS

The structure of a design orientated system is a function of the product characteristics and, in general, it is based upon such factors as geometrical definitions, functional requirements, material properties and size ranges (1). A.D.O. system based on the above considerations will remain virtually independent of company reorganisation or of changes in production methods and will satisfy the requirements of efficient design and variety control.

1.3 MANUFACTURING ORIENTATED SYSTEMS

The structure of a manufacturing orientated system is dependent upon the manufacturing facilities available in the company, and it is based on common manufacturing characteristics which require identical or similar operations on similar types of machines (3). It is true that components with similar geometries may be manufactured in the same way, but this should not be considered as the basis for structuring a M.O. system. M.O. sytems present problems in the case of technological process changes and do not tend themselves to design variety control because parts of similar design and functional characteristics may be dispersed (6).

2. THE COMPUTER CONNECTION

The introduction of computer systems which require a dialogue between user and machine, introduced a new dimension to the design of classification systems. At first sight it might appear that the huge computer power to handle complicated data structures would promote the idea of universal systems and make them more applicable to industry. Unfortunately this is not so for a number of reasons, the most important of which are:

1. Communication problems during interaction between (a) man/man, i.e. draughtsman to draughtsman and draughtsman to shop floor operator; (b) man/machine, i.e. draughtsman or 'terminal user' and computer. It is important to have a well defined design data language which allows interaction and dialogue to occur. Unless fully integrated CAD/CAM systems are employed, there will always be a need for a dual purpose language which serves both human/human and human/machine communication.
2. Industrial computer systems, are task orientated and despite the euphoria of turnkey systems, it is the author's experience that some degree of modification is always needed in order that the new system meets the specific company's requirements. This may not be so in the case of business systems... these follow standard procedured, and because of legislation they should conform to standard practice.

   It was found by a number of researchers (4, 7, 8) that department orientated classification systems were easier to use and understand than universal systems... they also took less time to implement and, most important, they were more acceptable to both management and workforce.

3. DUCTWORK INDUSTRY CHARACTERISTICS

The characteristics of the ductwork industry are considered in the following three categories:

3.1 Product characteristics
3.2 Manpower skills
3.3 Machinery employed

3.1 PRODUCT CHARACTERISTICS

The final product is a complete ventilation system which consists of individual ducting items. The architectural freedom given to the consultant in building design has discouraged the use of modular ventilation systems. It is only in recent years that the ductwork industry has been making an attempt to promote standard and modular designs. This situation, together with the long lead times experienced in the design, manufacture and erection of a system, and the major storage space involved, has prevented the evolution of standard batch production. Thus the industry has existed as a jobbing sector.

★ Both design and manufacture is very simple and no advanced technology is required for a satisfactory product.
★ The number of different component types used is limited.
★ All items (except the few which are pressed) are made from sheet metal blanks, and the material issued is predominently galvanised mild steel.
★ The basic operations for component manufacture comprise marking, cutting, bending and welding.
★ Both the level of dimensional accuracy and the quality of cut finish required is low in comparison to general engineering.
★ The final product forms a regular geometrical shape, therefore, simple mathematical geometry may be employed for development of the blanks.
★ The manufacturing process remains the same irrespective of the method of manufacture, i.e. manual or machine made.

3.2. MANPOWER SKILLS

★ The industry is highly labour intensive.
★ The skills requred comprise the following:
  (i) Skilled — for welding operations and marking out complex blanks.
  (ii) Semi-skilled — for semi-automatic marking and cutting operations.
★ The marking out process is based on a 2-dimensional i.e. flat co-ordinate system, and consists of orthogonal X and Y co-ordinates or arcs and radii.
★ Draughting and erection are independent activities and therefore manufacture can be sub-contracted.
★ An appropriate interface exists to translate, or manipulate, the existing design date into suitable manufacturing data.

3.3 MACHINERY EMPLOYED

— The machinery employed in the ductwork industry is, in general, of relatively low capital value, although exceptions exist.
— The different types of machine tools employed are of a limited nature and comprise shears, forming and bending machiens and welding gear.
— All machining is carried out in only 2 dimensions.
— Generally the machines operate in a discrete mode and there is a single action per set of data.
— The basic raw material is flat, metal sheet.
— Whenever sophisticated machinery is employed such as N.C. shears, the operating mode remains the same i.e. discrete motion, but the same type of data, X and Y, or mathematically defined curve is used.

4. THE CLASSIFICATION SYSTEM

Considering the above stated parameters a uniform pattern emerged which makes the ductwork industry suitable for a universal classification system. The classification system described in this paper can easily be applied in both computerised as well as manual environment. In particular this sytem developed by the author is already used by the host company as part of the company's application of computer methods; the COMPASS System (9, 10, 11) which is currently used by the company to layout and co-ordinate ductwork, to detail the layout drawing into individual components, provide data for manufacture. The system is also used to prepare costing and transport information and, finally, to plot conventional drawings for erection and other purposes.

The classification system consists of three parts which refer to:

4.1. Geometric shape
4.2. Interconnection arrangement
4.3. Blank configuration.

4.1. GEOMETRIC SHAPE

Sections — Ductwork components were grouped into four classes, as distinguished by their cross-sectional shape, namely, rectangular, circular, flat-oval and transformations. The four sections are shown in Figure 2. In the case of the first three it is required that both end sections of the component are of the same sectional shape but not necessarily the same dimensions. Anything which does not meet this requirement, namely a component which has end sections of different shapes, is classified under the heading, transformations, which covers any combination of the three shapes.

Types — Careful analysis of the current ductwork components identified groups of components which are of the same generic type. In order to be able to classify components, clear and well defined conditions had to be devised. The types are shown in Figure 3 and the conditions used to define these types are the following:

Transformer	— Different end sections
Straight	— Constant cross-section at any point across centre line. No offsets.
Bend	— Change of air-flow direction (non-parallel end sections).
Branch	— Taking off component from the side of another component to form a new duct branch.
Reducer	— Same airflow direction but different size end section.
Offset	— Same size end sections but with offsets.
Threeway	— Components with three and sections.
Others	— Anything not covered above

Specific Types — Each generic group of components consists of a number of similar components which might be able to peform the same design functions, but with a different efficiency or at a changed cost. Figure 4 shows a list of general component types and their specific types.

It was found, during the course of this investigation, that some of the names conventionally used to describe ductwork components, were misleading. For example, Figure 5 shows two components which have no resemblance in either geometrical shape or functional characteristics, but were both described as SETS.

4.2. INTERCONNECTION ARRANGEMENT

All ductwork components, as described in the section 'Geometric Shape', are connected together to form a ductwork layout. The methods used for connecting components depend on a number of factors, the most important being air velocity, pressure, cross-sectional shape and dimensions. These factors are subject to the project specifications. It is common for a specific component, such as a rectangular taper, to have different interconnection joints at each end, i.e. S cleat and drive flange at one end and an angle section flange at the other. This led the author to develop the concept of components owing their cross-joints. Every component is able, subject to contract specifications, to own any available cross joints and with any combination.

The interconnection arrangement consists of three elements namely (a) arrive cross joint, (b) leave cross joint and (c) offline cross joint. All three elements are shown in Figure 6.

No significance was placed on the names chosen, other than for conventional purposes. Equally it is possible to use cross joint A, cross joint B, cross joint C or any other covenient names. The choice however was based on the logical assumption that designers layout ductwork in a specific direction and so the first cross section is defined as the arrive whilst the next is the leave cross joint of the component under design.

Careful analysis of the company's practices and naming conventions identified that, prior to introducing the classification, there were eighteen different cross joints in use. There are shown in Table 1. It was apparent that some joints were identical but carried a different name.

NAME	DESCRIPTION	CODE
SD	S and Drive cleat	1
DF	Drive Flange	2
SDF	Standing Drive Flange	2
PFJ	Peened Flanged Joint	3
RE	Raw Edge	4
FJ	Flanged Joint	4
BS	Butt Strap	4
SF	Self Flange	5
EF	Edge and Flat	6
SWJ	Spot Welded Joint	—
WF	Welded Joint	—
WRJ	Works Riveted Joint	—
M	Male Joint	7
F	Female Joint	4
PJ	Pittsburgh Joint	8
TJ	Tab Joint	9
SJM	Slip Joint Male	—
SJF	Slip Joint Female	—

Table 1 pre-Classification of Cross Joints and after classification allocation of digits.

For manufacturing purposes, however, the definition of cross joints was further developed and thus it referred to the following:

1. the dimensional allowances that were required to be added to the basic blank geometry and
2. the manufacturing method needed to form the cross joint.

Figure 7. shows how two straight components, one with SDF (Standing Drive Flange) and the other with a DF (Drive Flange) are identical and thus, they are namufactured from the same blank configuration. Their difference is located in the cleat which holds the two components together. A similar analysis reduced the numberof cross joints from eighteen to nine, and in addition, it revealved more misleading names and conventions. For example, the two components shown in Figure 8 were defined as a slip joint, yet, in practice, they were given two identification numbers and two erection incentive times. By applying the cross joint definition and classification principles, the slip joint was not a cross joint but an assembly of two different components owned instead, a RE and an EF at their adjacent ends, see Figure 8.

4.3 BLANK CONFIGURATION

The blank configuration of the classification system covers the sheet metal blanks. These blanks represent the basic part, which, after the geometrical development, the 3-dimensional component will emerge. Figure 9. shows how a straight piece of ductwork could be made in four different ways.

1. by using one blank... this is bent to produce all four sides. There is one longitudinal joint at one corner.
2. by using two blanks, of which one is bent in a U-shape, to produce the three sides whilst the other one represents the fourth side. There are two longitudinal joints along the edges of the fourth side.
3. by using two identical angle shape blanks, there are two longitudinal joints at opposite corners.
4. by using four blanks, each representing a side, producing four longitudinal joints at each corner.

Theoretically, any of the four configurations are possible. Reality, however, imposes some considerable restrictions, such as the size of the available metal sheet, the economics of cutting, bending and welding operations, and the resulting waste; all this necessitates a careful consideration of which configuration to use. The selection of the optimum method is achieved by a process of elimination. Starting with one blank and finishing with four. The lenght and cross-sectional dimensions of the straights is compared with the physical size of the metal sheets available.

The same philosophy was applied to all ductwork components and thus, a set of 2-dimensional blank drawings was produced and retained on the shopfloor for reference. The drawings were parameterised, thus, they were independent of a 'component' actual dimensions. For every component that is to be manufactured, a ticket, or manufacturing report, is produced which gives the sheetmetal worker all the actual dimensions required. Figure 10 shows a parameterised blank drawing which is used for the production of a straight component made from a single blank. The first piece of information on the tichet is the component classification code which identifies the blank drawing required.

5. CODING

The classification system developed was coded in the following format, see Figure 11:

Geometry/interconnection/blank
abc/def/g

where:

a = Section
b = Types
c = Specific Type
d = Arrive Joint
e = Leave Joint
f = Off line Joint
g = Blank Configuration

The numerical values allocated to the various digits are shown in Figures 2, 3 and 4 and Table .1.

The coding adopted has a polycode format which offers the advantage of expansion. The basic code of the system covers components in a broad sense and avoids detail descriptions of the component's physical shape, interconnection method and method of manufacture. Other codes can be added to the basic code to describe a category or sub-category of component characteristics. In addition to the above characteristics each componet haw some other attribates ie size wich via the Scheduler facilitiys, they are manipulated and new characteristics are generated and added back for the component's full definition, in particular to cover manufacture. The classification developed, however, had the objective of being independent of manufacturing facilities. In addition it had to avoid repetition of the same information which was directly dependent on the basic data given on other monocodes.

.6 CONCLUSIONS

The classification and coding system described in this paper has now been deployed within the host company for some time, and the benefits predicted have been realised.

Specifically, standardisation took place and economies of scale have being achieved. Although the motivating force behind the design of the classification system was the initiation of computer Aided design methods companies derive many benefits from the use of a well designed classification scheme.

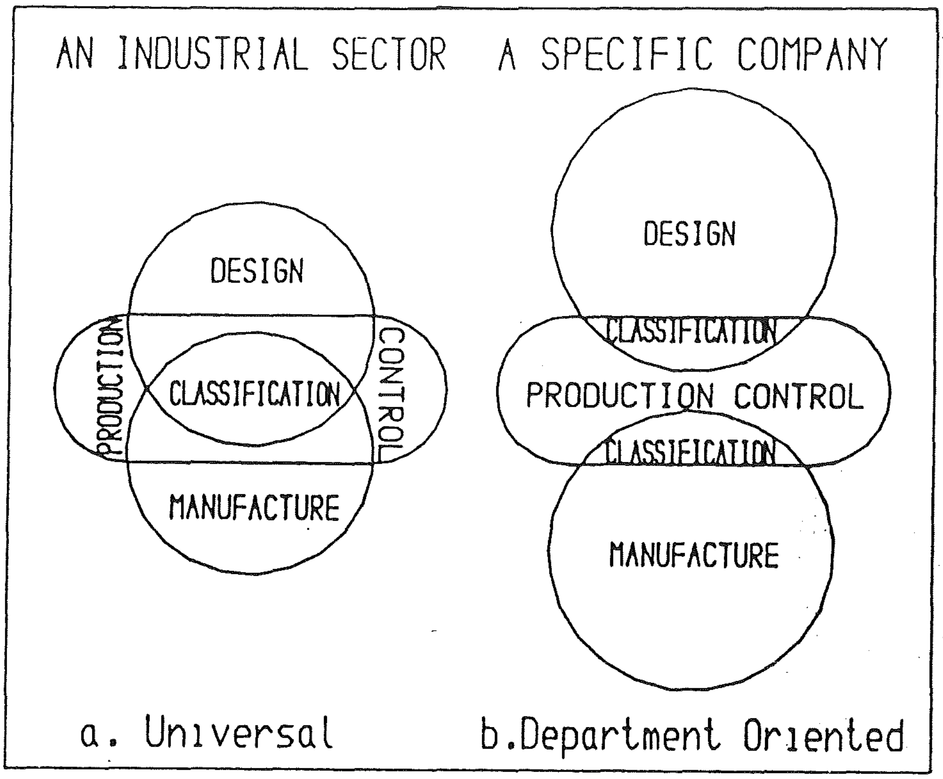


Figure 1. Types of CLASSIFICATION systems.

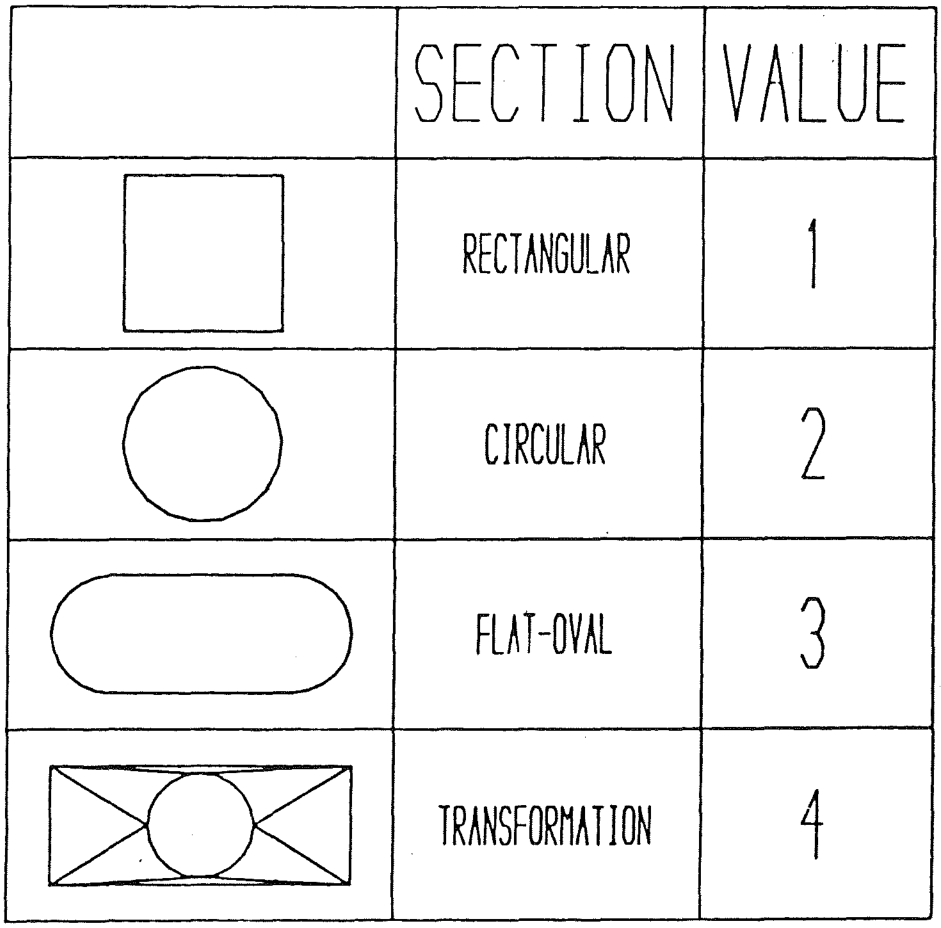


Figure 2. Classification of items by cross-section

TYPE	VALUE	RECTANGULAR	CIRCULAR	FLAT-OVAL	TRANSF/ON
TRANSFORMER	0				40
STRAIGHT	1	11	21	31	
BEND	2	12	22	32	
BRANCH	3	13	23	33	
REDUCER	4	14	24	34	
OFFSET	5	15	25	35	
THREEWAY	6	16	26	36	
OTHERS	7	17	27	37	

igure 3. Generic Types of Ductwork components.

TYPE	SPECIFIC TYPE	
TRANSF/MER	SQ-RD	1
	SQ-FO	2
	RD-FO	3
STRAIGHT	STANDARD	1
	NON-STANDARD	2
	NECK	3
	COUPLING	4
BEND	RADIUS	1
	SEGMENTED	2
	PRESSED	3
	MITRED	4
	BOX-MITRED	5
BRANCH	BOOT	1
	STRAIGHT	2
	ANGLE	3
	CONICAL	4
	FISH	5
REDUCER	PRESSED	1
	FABRICATED	2
OFFSET	CRANK	1
	SWAN	2
THREEWAY	PRESSED SWEPT	1
	SWEPT	2
	BREECH	3

Figure 4. Ductwork Components and their Specific Types.

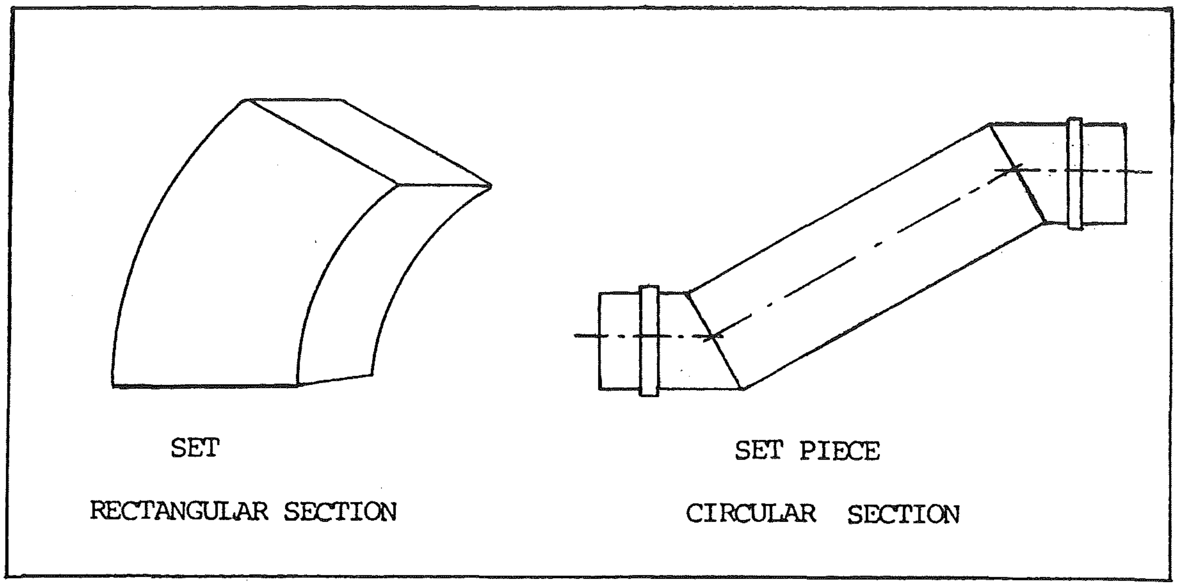


Figure 5 Misleading component names.

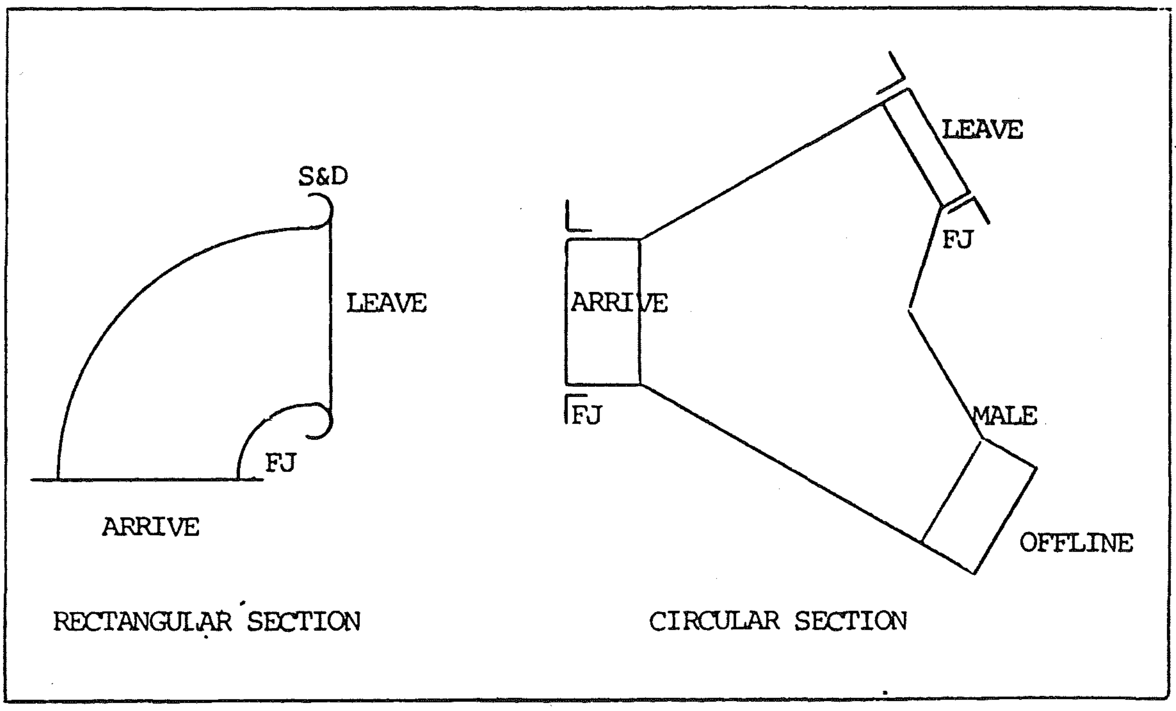


Figure 6 Interconnection Cross Joints.

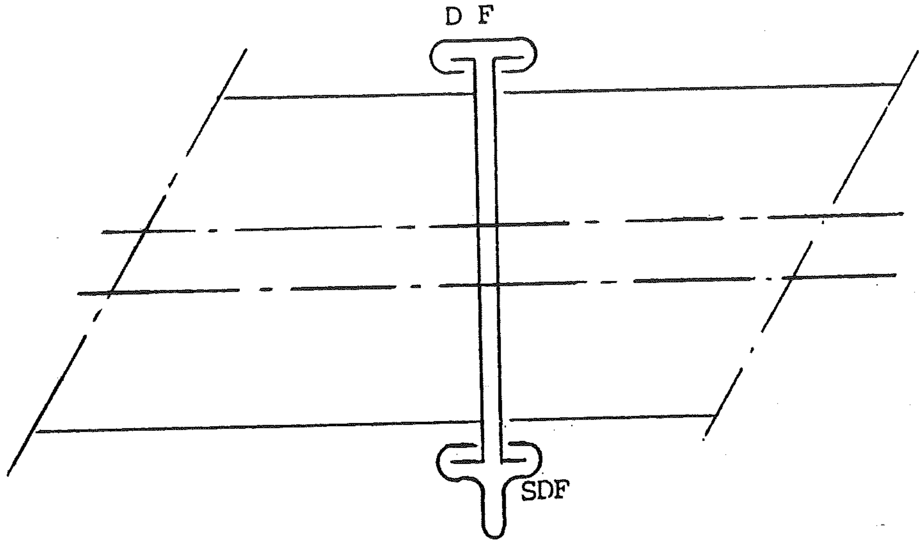


Figure 7 Comparisson of DF and SDF cross Joints.

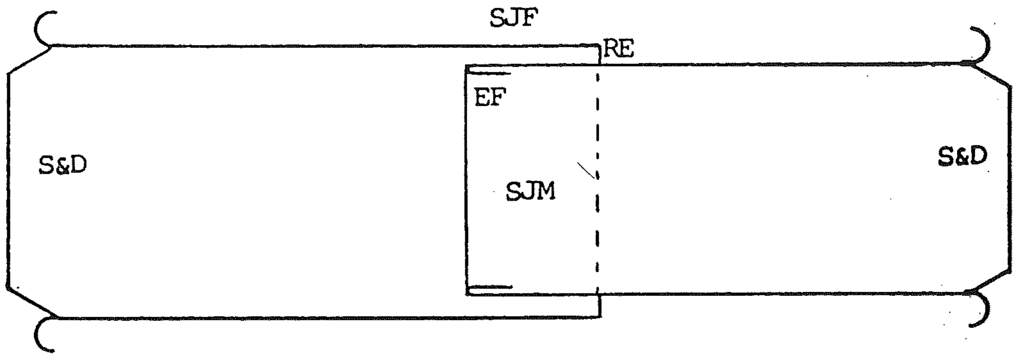


Figure 8. A skematic comparisson of EF,RE Vs SJM and SJF.

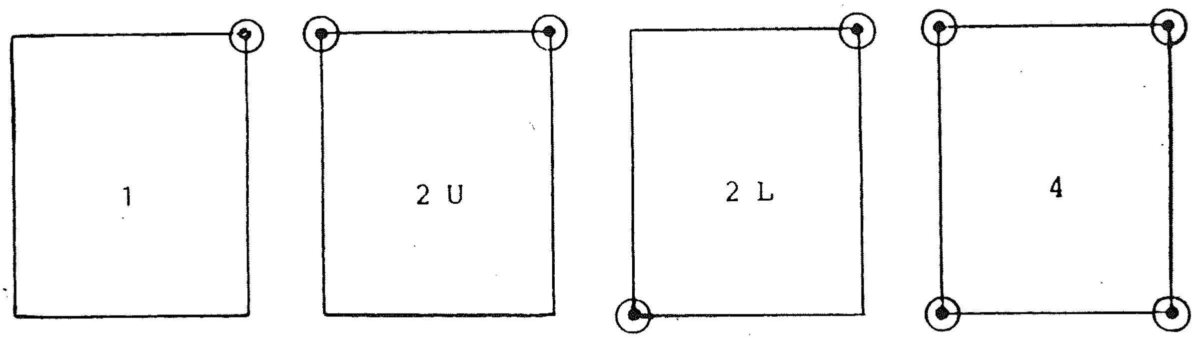


Figure 9. Possible blank configurations for the manufacture of straigh

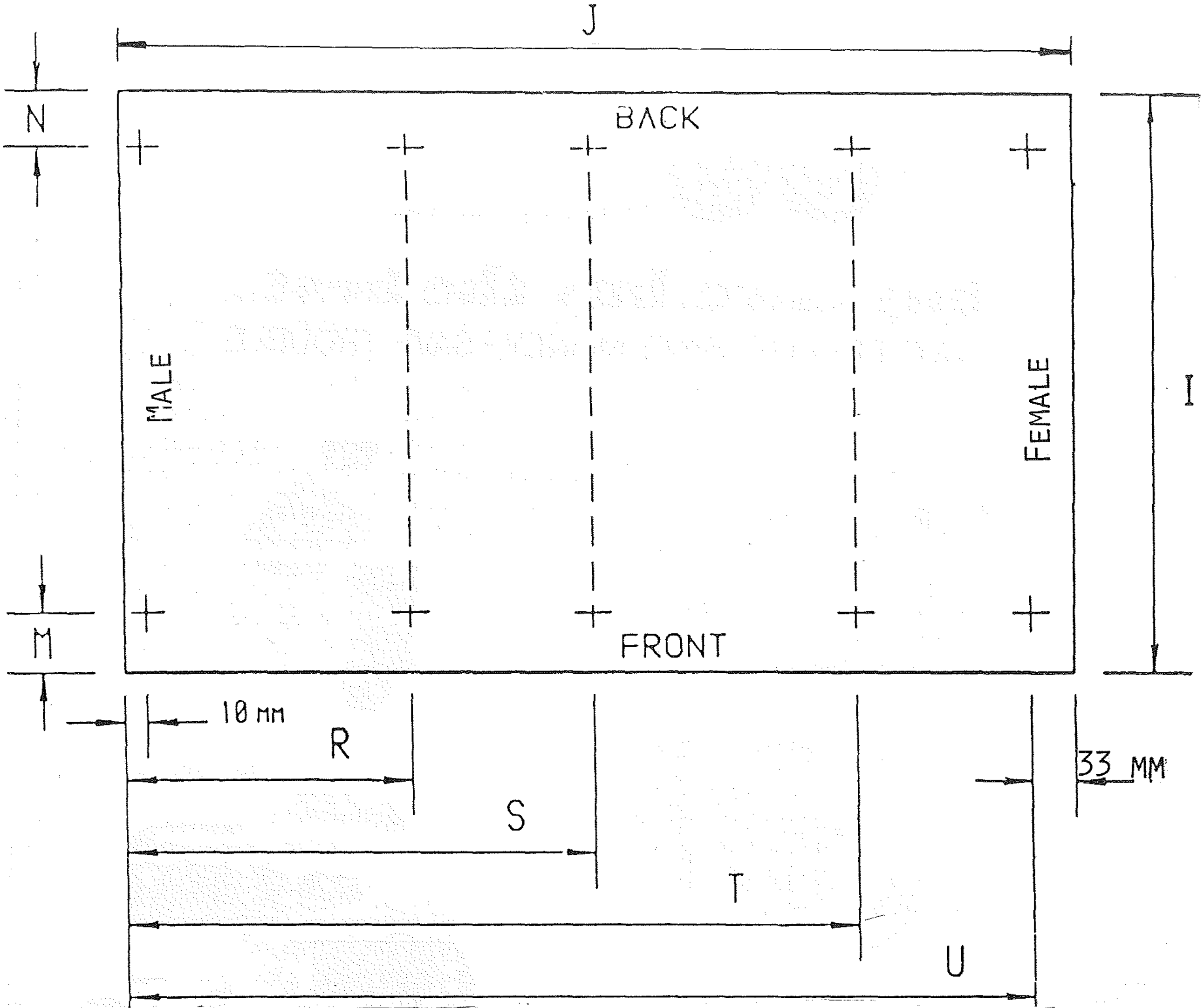


Figure 10. A parametarised blank for the manufacture of a straight.

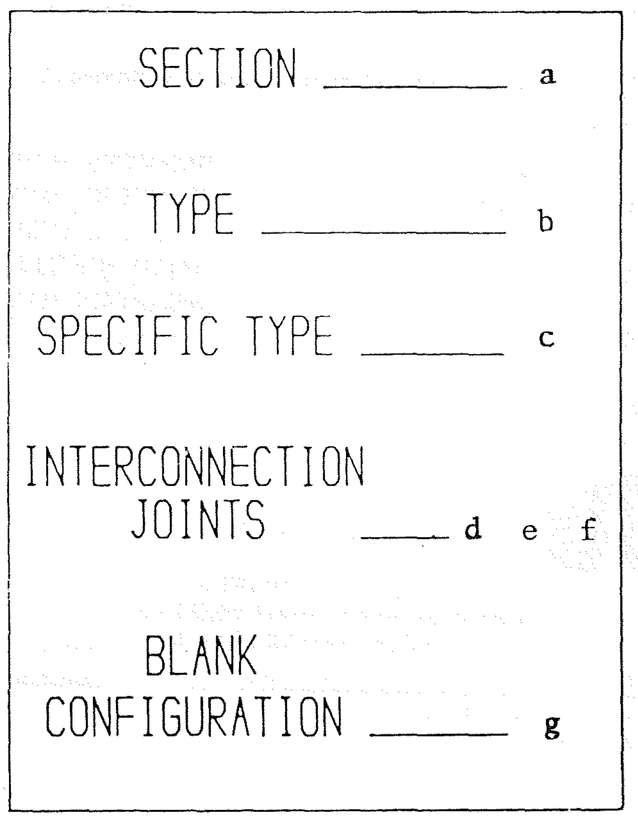


Figure 11. Allocation of Digits.

THE EFFECT OF THE COMPUTER REVOLUTION ON THE COLLEGE MATHEMATICS CURRICULUM

By George N. Philippou M.A., Ph.D.
Lecturer-HTI.

A. INTRODUCTION

The rapid growth of computers during the last fourty years has opened new avenues and gradually altered the face of applied mathematics. First came the development of numerical analysis which met the need for changing the continuous functions so as to be adaptable for computer use. Next the algorithmic approach was developed and combinatorics, graph theory and multivalued logic came in to serve the solution of practical problems. In the meantime the volume of new developments in calculus, traditionally assumed to be the core of all mathematics, was steadily decreasing. On the other hand the number of research papers in discrete mathematics is increasing and it seems quite certain that this increase will be even greater in the future.

The direction towards mathematics is moving should certainly be reflected in the mathematics curriculum. Since this curriculum should be catering for the needs of the future society it cannot be outdated at a moment where the Japanese fifth computer generation is almost a reality.

In an effort to enhance the development of the new carricula the College Mathematics Journal, offered its pages for an open interactive exchange of views in the form of a Forum. The discussion was focussed on the following two topics:

(i) On the relative importance of calculus and discrete mathematics
(ii) On the College Introductory Mathematics Curriculum.

A target article was written on each of those two topics by one of the top specialists in the field. This article was then given to a number of other professors to read it and express their own views. Finally the writer of the turget article was given the opportunity to present his concluding comments in the light of the arguments produced against his initial thesis.

A brief summary of the main points raised in the FORUM are presented here, in the order mentioned above, for the readers of the HTI REVIEW.

B. The Relative Importance of Calculus and Discrete Mathematics.

The opening article was prepared by Antony Ralston a well known Professor of Computer Science and Mathematics at Baffalo. His main thesis was that "... *the relative importance of classical applied mathematics is lessening*" and that in particular "... *the decrease in the importance of calculus in the world of mathematics is accelerating*".

His main arguments were:

(i) Classical applied mathematics has been a tool to understand the physical world. That understanding is still far from complete, while the classical applied mathematics is no longer a growht area.

(ii) The development of computers has opened up a vast new area for the application of mathematics. The need to convert the continuous equations and functions into the discrete form required by the digital computer has resulted in an explosive growth of numerical analysis and discrete mathematics.

(iii) Discrete applied mathematics came to be seen as an area which need and could develop on its own as the importance of algorithms and their analysis became recognized in computer science. Just as classical analysis fostered and in turn it was forced to develop by the first industrial revolution, discrete mathematics is now supporting and being developed by the second industrial revolution, one that focuses on knowledge and communication rather than on the material world as did its predecessor.

The following examples are worth noting.

— Compinatorial methods have been applied to the analysis of algorithms in general and in particular to such areas as searching and sorting.

— Graph theory has been applied to networking problems.

— The Fast Fourier Transform was fostered by the need for efficient computational methods for very large numbers.

— Mathematical logic has been widely used in artificial intelligence as well as in computer design. Now, it plays a major role in the Japanese fifth Generation project in which the hardware will be designed to perform millions of logical inferences per second and in which the standard programming language would be PROLOG — "programming in logic".

— Computational complexity is a new branch of mathematic whose development has been due entirey to the need to analyse algorithmic methods.

(iv) It is ferecasted that the problems which applied mathematicians will be called upon to solve will be mostly related to computers and computer science. Thus, apart from the students of computer sciences, the students of social and management sciences as well as the students of physical sciences and engineering will increasingly need to formulate and solve their problems in discrete terms so that they can be solved on computers.

The final suggestion is that "... the time has come for discrete mathematics to play a coequal role with calculus in the first two years of college mathematics".

In response to A. Ralston's thesis the following views were produced.

1. **S. Maclane,** The University of Chicago.

He refuses the assertion that "classical applied mathematics is no longer a growing area". He mentions the new techniques for handling classical non-linear problems the remarkable new connections between geometry and theoretical physics, and the many developments in the applications of higher analysis.

Calculus is a "coherent and deep intellectual discipline with manifold roots in science". Discrete mathematics is "a grab bag of all sorts of things", from graph theory to number theory, some deep some disconnected. Thus the idea to reduce the teaching of calculus in favour of discrete mathematics would mean to downgrade mathematical education by the coherence of the whole subject.

2. **D. Wagner,** Researcher in Operations Research.

The addition of computer — motivated discrete mathematics to the first two year's curricula may be quite useful in applications. However, "the area of one's specialization and the techniques one has learned are not so important as the ability to device new techniques to meet new kinds of problems". This is greatly enhanced by excellence in graduate education and thesis research.

3. **P. Hilton,** SUNY Center Binghamton, NY.

Discrete mathematics is of great importance and it should certainly take its place alongside the calculus in the core mathematics curriculum. The face of college mathematics and calculus sequence will no doubt change. There must be new emphasis and certain topics should be treated with benign neglect. But calculus is indespensable and the core mathematics should be presented as an integraded whole where the role of calculus will by no means be the second.

4. **R. L. Woodriff,** Menlo College, C.A.

The curriculum must certainly undergo growth and change by including some numerical methods, digraphs, networks and combinatorics, but "the next generation should not be deprived of the precious continous mathematics tool and the ceherent view of mathematics that calculus provides".

The discrete mathematics mevements is compared to the school "New Math Graze" of the 1960's which has already reached a steady state.

5. **D. J. Kleitmen,** Massachusetts Institute of Technology.

Using the computer we can solve model equations which once were intractable. The range of potential practical applications has been enormously expanded by computers. But "most mathematical research, even in discrete areas, uses all sorts of ideas that the student first encounters in studying calculus". And the conclusion is that "... the cutting down on calculus is a terrible idea, even if done in order to teach material from my field."(!). Discrete mathematics, yes but not at the expense of calculus.

6. ***P. Lax,*** Courant Institute of Mathematical Sciences, NY.

Today's computers make possible numerical and symbolic explorations on an unprecedented scale; much physical experimentation can now be replaced by numerical modeling. The availability of computing has brought to the fore an impressive array of discrete problems, very challeging intellectually and important in applications. But it is wrong "to say that calculus has lost in any sense, relative or absolute, its importance in formulating notions and solving problems of mathematics". Classical applied mathematics is still a growing area. Among the developments of the last 25 years one car mention: the theory of analytic functions of several complex variables, modern differential topology, the achievements of modern dynamics, fluid dynamics, computational fluid dynamics etc. The final conclusion is that "a calculus deficient education would shant students into a small corner of mathematics, instead of opening up its whole panorama.

C. **The Introductory Mathematics Curriculum**

The opening article on this topic was written by Professor F. Roberts a very distinguished researcher, author and editor of books on discrete mathematics and mathematical modeling, now at Rudgers University.

His main premise is that **"today's introductory curriculum in mathematics is misleading, outdated and unfair".**

Hence he continues to justify his pemise by listing a number of major goals of the introductory curriculum which the present curriculum fails to fulfil.

A first goal of the introductory curriculum is to give a survey, or an averview of what the modern mathematical sciences are all about. Since the traditional curriculum is treating only one aspect of the subject i.e. calculus and differential equations, and disregarding the increasing significance of numerical methods and discrete mathematics, it is giving a misleading, or biased view of what mathematics is all about.

A second goal is "to turn on" potential mathematics majors and get them interested in pursuing the subject further. By omitting the new topics which deal with modern applications, the introductory curriculum is too outdated to be relevant and it turns most students off.

A third goal is to prepare students for more advanced courses in mathematics. But the courses which the "typical" mathematics major takes are increasingly courses in discrete mathematics i.e. combinatorics and graph theory, algorithms, probability and statistics, numerical analysis, mathematical modeling and operations research. But those subjects do not need much of the calculus now taught during the first two years. On the other hand a greater emphasis on these subjects during the first stage would lead to the same high level of mathematical maturity while leading students to more serious advanced courses in these subjects. This would be a less unfair curriculum than the existing to the majority of today's students.

A fourth goal is to prepare students for courses in other disciplines. But for the student of business administration or economics, or biology a "modern" curriculum with due emphasis on discrete mathematics is more relevant than the present. On the other hand the students of physics and engineering need calculus and differential equation. True; but they also need early exposure to computers and the mathematics relevant to computers, and probabilistic ideas. Thus, the present curriculum is unfair to these students as well.

The present curriculim does begin to introduce students to precise mathematical reasoning, rigor and abstraction. But an alternative curriculum could do the same as well and perhaps more motivating students by emphasizing the usefulness of mathematics.

The conclusion is that "modifying the first two years' curriculum should be a high priority". A first possible approach is to "develop a "unified" introductory curriculum, which combines calculus, discrete mathematics and other topics. The other is to develop separate introductory courses in discrete mathematics and related topics, to be given in the first two years, either in parallel with or in place of some of the calculus".

The following comments are assumed to be the most important of those written about Roberts' article.

1. **W. F. Lucas,** Claremont Graduate School, CA.

The ongoing revolution in digital computers will eventually cause major structural changes in mathematics education at all levels.

There is no evidence that discrete mathematics do not provide the things we now consider precious for training mathematicians. In fact "the current abstraction unification, generalization, and synthesis taking place in combinatorics, is creating a new modern algebra that should be just as mathematically rich as the current algebra".

It seems that "the more recently created mathematical subjects deal with human behavior, interaction, organization and decision making, rather than physical objects and their dynamics".

The location of calculus and analysis within the sequence of mathematics courses cannot change significantly. The ultimate solution should be the "sufficient inclusion of large doses of discrete mathematics at precollege levels.

2. **R. W. Hamming,** Naval Postgraduate School, Monterey, CA.

It is not a question *"of discrete vs. continuous mathematics"*. Instead of the "guided tour through the art gallery of mathematics", we must teach students "how to create the mathematics" they need.

Probability and statistics are now very important in most areas of the use of mathematics. But, the purpose of computing is insight and usefulness. Further "we must teach style in creating mathematics, not just the results of applying past methods".

3. **D. Hall,** Mathematics Education Research Center, University of Warwick, Coventry, England.

Algorithms and finite mathematics are of vital relevance, but these "complement traditional mathematic rather than replace it". Computing can give insight into classical mathematics, and classical mathematics can give insight into computational techniques. "The Worlds of continuous classical mathematics and discrete modern computing are complementary; they are not alternatives".

4. **R. B. Davis,** University of Illinois at Urbana.

Adding some topics from finite mathematics "is an excellent idea, but what is even more essential is the creation of courses that focus on concepts, on the intellectual analysis of mathematical cituations and on the use of heuristics in problem solving".

Mathematics has become so important to so many people that it is threatened with emasculation. Faced with this need, "we are all too often telling students some key formulas, and showing them how to make numerical replacements for the variables. "*Even by generous estimates this barely quilifies as mathematics*". Changes in the introductory curriculum are urgently needed, but the introduction of more discrete mathematics will not necessarily improve the situation. It is not only what we do, it's at least as important how we do it.

5. **W. Ellis, Jr.,** West Valley College, Saratoga

Curriculum change is certainly needed, but this will not be enough. Our techniques for teaching mathematics are also outdated. Many of us still rely heavily on the lecture, a technique developed long ago. But, large lecture sessions and multiple choice examinations can only offer a "going through the motions".

Mathematics is more than theorems and proofs, it is also a human activity consisting of "the struggle and joy of creating those theorems and proofs". In the long run "we must provide students with the intellectual strength to do mathematics on their own". Not research, certainly, but to be able to learn "new" mathematics from written material in their chosen fields.

6. **J. Mason,** The Open University, England.

Calculus will not be the axis of college mathematics for long. But, replacing calculus with cominatorics, or any other topic area is not likely to make much difference by itself. "Curricular change must be accompanied by severe questioning of current teaching methods, and by change in teachers' attitudes toward what consittutes mathematics".

7. **R. K. Guy,** University of Calgary, Alberta CANADA.

Why are we not moving rapidly toward currculum change including more of the modern subjects? Because:

— We are in "the grip of the textbook publishers. Innovative curricula and syllabuses don't make money".
— We are conservative and take the line of least resistance.
— Operations research and combinatorics haven't yet found their identity.

— Calculus is easier to teach and easier to learn than finite mathematics.

D. Some Comments on HTI Mathematics Curriculum

The introductory mathematics curriculum as discussed in both parts of the FORUM is clearly comparable to the mathematics curriculum of HTI. Since the aim of HTI is to train "technician engineers", the mathematics curriculum was designed to be a service subject, and quite rightly. It was a "unified" curriculum extending over the first two years and, with emphasis varying according to specialization, included: calculus, differential equations with Laplace Transformations (not for the students of civil engineering), some elements of linear algebra, and probability and statistics. The subject was treated mostly from the practical point of view with applications, but the level of mathematical rigor was low. At the extreme, some of the students would only learn how to "make numerical replacemtns for the variables" in a given formula. However, the general feeling is that the final outcome was satisfactory.

During the latest syllabus revision we have managed to include more numerical methods and finite mathematics. A new, year subject was intoduced on numerical methods for the students of electrical engineering. That was definitely a step towards the correct direction. But since we cannot be "misleading, outdented and unfair", particularly when a considerable proportion of our students pursue further studies, we have to prepare for the next steps, which have to be substancial. Change, in my opinion, should be prepared in the direction of:

(i) More emphasis should be paid on mathematical rigor. This could be done without omitting applications, only by a better utilization of the time.

(ii) More modern subjects should be included in the existing unified curriculum by deemphasizing parts of the now existing. This will assume a careful preparation and probably a study on the field of what other advanced countries do, or they are planning to do.

(iii) A third step, which is quite urgent and rather easier, is the development of our own textbooks. We certainly have the competence and the modern technology makes this target feasible at a low cost. Concerning the importance of this, I just quote Professor Hamming: "Without a textbook to teach from, what you have just said is of no importance".

Source: *The College Mathematics Journal,* Vol. 15, No 5, 1985 pp. 371—399.

ENERGY MANAGEMENT IN INDUSTRY

by G. Iordanou BSc, MSc, CEng. MIMarE
Head, Mechanical
Eng. Department
HTI

Introduction

Most industries have considered doing something about their energy consumption at one time or another. Careful planning is required if maximum results are to be achieved. Unfortunately, no short-cuts exist when it comes to energy conservation and certain work procedures must be followed in order to achieve a satisfactory result. This work schedule is shown here:

Project planning
Energy audit
Energy balance
Measures to reduce energy utilization
Energy and cost calculations for all measures
Priority list of measures
Organization of energy saving activities
Training and information
Project planning for the measures
Follow up of implemented measures

Project planning

When planning the scope of a project it is important to specify the goals and results which should be arrived at and to determine time and cost frameworks. This should be done during the preliminary planning stage. It should also be decided as to which people are to be involved in the project and what their responsibilities should be and also the areas where expert aid is to be utilized.

Sometimes it can be advantageous to employ experts for the preliminary planning stage of the project. This is especially true in regard to large projects or where the expertise of own personnel is insufficient. In the case of large projects it can even be advisable to train own personnel in the initial phase of the project as they can then work together with external experts in the planning stage and during the later stages.

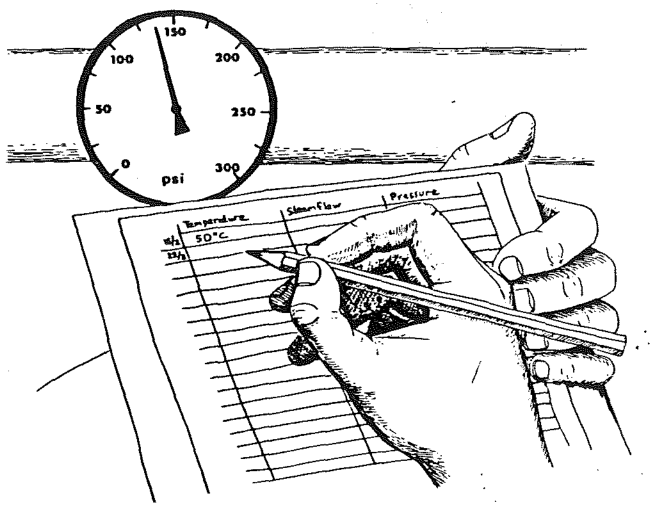
If experience in energy conservation work is not adequate, then the conservation project should start with seminars or courses.

It is suggested that courses and seminars of this kind should be organised in close cooperation with experts in the respective fields.

Energy Audit

An energy audit must be carried through at the factory or industry in order to be able to determine the energy flows within the industry.

In order that the energy audit be effective, it is very important that the aims of the project be well defined to



ensure that the results truly provide the neccesary data needed for the evaluation of saving potential. It is essential that qualified exprerts are and foremost, in the fields of measurement, energy and process engineering.

The precise form of data collection will depend upon the size of the organisation, its function and its complexity, but most energy audits can conveniently be undertaken in several phases.

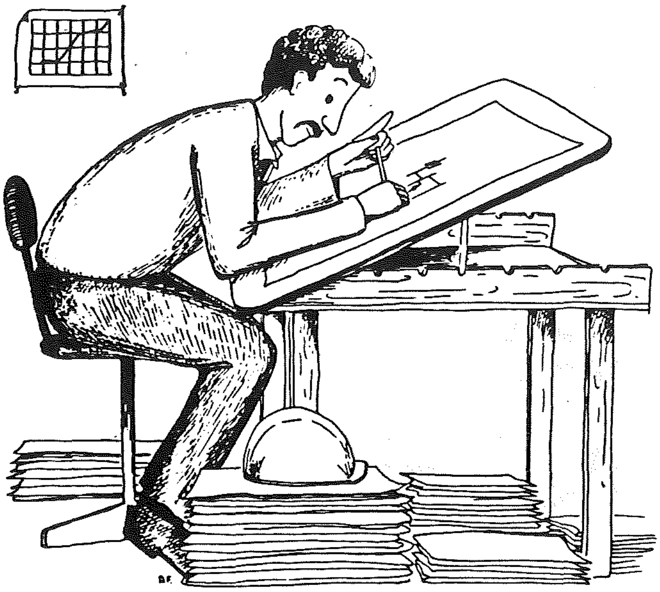
A. Fuel and energy purchases
B. Energy used by various departments
C. Energy used in various processes within departments
D. Energy waste checklists

Examples of analysis forms shown in the appendix are for guidance only and users should develop forms to suit their own particulat needs (see Appendix page 14,15,16,17)

The result of the energy audit should be an energy balance; this requires the application of the Steady Flow Energy Equation across every piece of equipment which forms part of the process; tables and charts on properties of refrigerants, gases, steam, hydrocarbons and other fluids will be necessary for determining energy transformations across plant components. A detailed study of the energy balance allows an evaluation to be made as to which energy conservation measures should be implemented.

Energy balances may be presented in a number of different ways e.g. in table or in diagram form. Usually, the most perspicuous manner in which to present an energy balance is in a Sankey diagram.

Feasibility study



Proposals regarding measures which can reduce energy costs can now be submitted. The energy balance is the basis for such proposals, but they are to a large extent also dependent on experience and know-how in the field of process enginnering.

It is advisable to use an external expert for this work in the case of a smaller project since the experts' services are only required for a short period. It is more appropriate to train own personnel in energy matters for long term projects e.g. energy conservation as then know-how is always at hand.

Energy conservation measures cover a very wide range of activities from tightening valves to the recovery of large quantities of waste heat at an industrial plant.

Considerable savings can often be achieved by very simple measures.

The measures which are proposed during this phase of the project are assessed from energy and cost viewpoints and profitability analyses are made. This results in a priority ranking of the measures; some of these should be implemented immediately, others should perhaps be implemented at a later date and perhaps others are judged as being unprofitable. This can include measures which are to be carried out during a time period spanning some years into the future.

The package of measures must be drawn up in such a manner that it can both be handed over to the technical staff who is going to implement the measures and also be presented to banks and company boards who are going to finance and agree to the proposal.

APPENDIX

A. Energy purchases summary Period from to Reference

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Energy	*Grade or specification*	*Unit*	*Total purchased*	*Total cost*	*Average cost per unit (5) ÷ (4)*	*Calorific value (net)*	*Total energy content (4) x (7)*	*Average cost per standard energy unit (5) ÷ (8)*
Coal								
Oil								
Gas								
LPG								
Electricity								
Other								
Prepared by		Overall cost (10)			Overall energy use (11)			
Date		Notes						
Examined by								
Date								

- A form of this sort should be used to make periodic overall energy reviews.
- The data provides a general indication only of an organisation's energy use and costs, as a starting point for conservation.
- It takes no account of handling and storage costs, convenience, premium values, etc, or of the efficiency of use.
- For cost comparisons between different fuels, total heat contents (8) should be in the same standard units. Use the conversions in Appendix A.
- Overall energy use (11) can also more readily be monitored if standard units are used.

B. Energy used by departments

Period from to Reference

(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Department	*Section*	*Energy*	*Coal*	*Oil*	*Gas*	*LPG*	*Elec.*	*Steam*	*Total standard units ( ) (3) to (8)*	*Output or production index*	*Energy productivity (9) ÷ (10)*
		Grade									
		Unit (M)									
		M to S	X	X	X	X	X	X			
		M									
		S									
		M									
		S									
		M									
		S									
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		M									
		S									
		M									
		S									
		M									
		S									
		M									
		S									
(12) Overall measured units		Σ M									
(13) Overall standard units		Σ S									

Prepared by		Notes
Date		
Examined by		
Date		

- Conversion from measured units (M) to standard energy units (S), e.g. kWh or Btu, greatly facilitates comparisons. Include conversion factors (M to S) on the printed form for each energy source and state the standard unit under (9).
- Energy productivity (11) should be monitored only if production or output is significantly related to energy use.
- Columns (3) to (8) should be designed to suit the organisation's fuel pattern.
- Overall energy use in standard units (13) should be related to overall production, weather conditions, etc.

C. Energy end-use survey

Department Reference

Survey by Period of survey from hr on until hr on

(1)	(2)	(3)	(4)		(5)		(6)	(7)	(8)
Plant or end-use	*Ref. or code*	*Energy type*	*Energy consumption rate*				*Peak month*	*Thermal efficiency (estimate E)*	*Comments*
			Average	h/day	*Maximum*	*Time*			

- It is important to record the precise period during which the survey is carried out.
- Note should be made of known daily consumption peaks, especially of electricity. The maximum consumption rates and times at which these occur should be recorded.
- Known seasonal peaks should also be noted.
- The survey will help to identify major energy-using plant, assist comprehensive listing, and indicate shortcomings in measurement and control.
- Estimate efficiency if no figures are available and follow up with actual tests. 'E' in column.
- Note any obvious shortcomings and record on form D.

D. Energy waste checklist Department Reference

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plant or end-use	*Ref. or code*	*Waste noted and action required*	*Noted by*	*Date*	*Action by*	*Date*

- All identified energy waste should be recorded and a follow-up made to ensure that action has been taken.
- Specific waste noted during general surveys should be entered on form D for action, otherwise it may be overlooked.

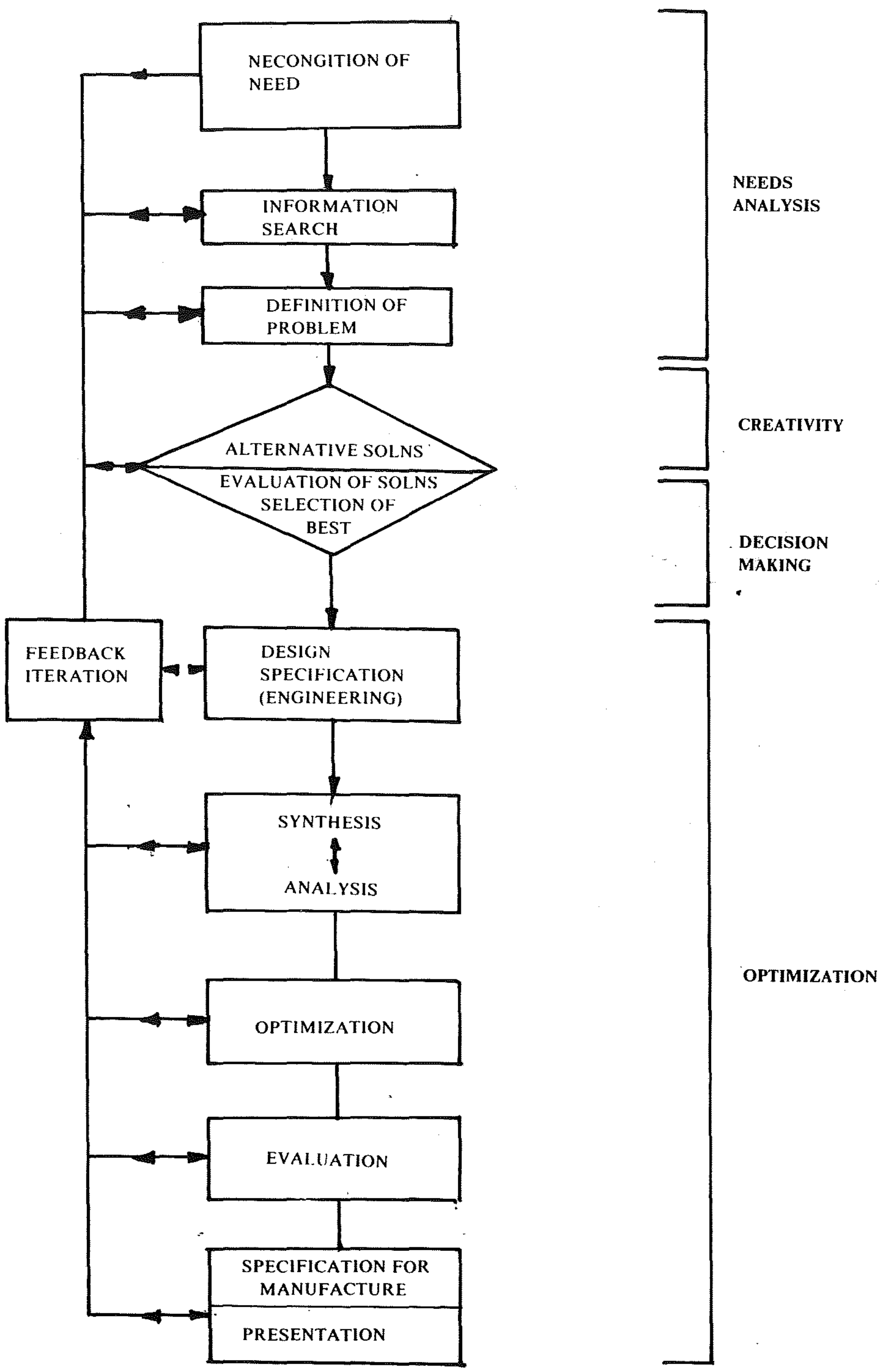
INVENTIVENESS IN ENGINEERING DESIGN

By Constantinos Neocleous, B.E. M.Sc. Lecturer H.T.I.

> "Invention is 95 perspiration and 5 percent inspiration"
>
> T. Edison

A typical design process widely accepted and practiced by many successful designers is shown in block diagram form in figure 1.

The design process



It is seen that the heart of the process is the **creativity phase**, during which, the designer seeks to develop many innovative ideas / solutions aiming at satisfying a well defined need.

An innovative design is usually that which is considered to satisfy all of the following qualifications:

(i) Must be **new** and **unique**
(ii) Must be **useful** or appreciated
where previously there had been complexity)
(iv) Must create new relationships.

Inventiveness and creativity (which is very similar to inventiveness except that it is usually related to non-existing things that are created) depend largely on heredity, environment and past training of the individual. In addition, for modern engineers, inventiveness depends to some extent on scientific and technical knowledge and understanding.

An inventive person does not have to be very intelligent. In fact, studies have shown that there is a negative correlation between inventiveness and extreme intelligence (above IQ = 160).

Most people though are not lucky enough to be borne either very inventive or very intelligent. An obvious question that comes to mind is whether one can improve his or her capacity to generate inventive ideas / solutions. Most, have, to some extend the potential to be inventive. Thus it is possible to let this latent potential be manifested at the right time. To achieve this, one has to :

(a) Avoid restrictions to the path of development of inventiveness
(b) Stimulate inventiveness.

A. Restrictions to Inventiveness:

(i) **Psychological Set.**

This is a predisposition to a particular method or way of thought in solving a problem. It is related to habit and conservativism. For example the commonly found bias in favour of advance mathematical techniques in solving problems.

Psychological set is promoted during states of **anxiety** and **tension.** Also **familiarity** increases set.

It is fortunate though, that set may be easily corrected by simply being aware of it.

(ii) Making Premature Judgements

Let ideas spark freely. Don 't make judgements on whether they are good, suitable, economic, bad, ugly e.t.c. until after the creativity phase.

(iii) Question Authority

Too much authority might inhibit creativity, or exclude some possible ideas.

B. Stimulating Inventiveness - Techniques

At H.T.I. in the subject of Mechanical Design the following techniques are usually taught:

1. Memory Expansion
2. Trigger Word
3. Analogy
4. Empathy
5. Fantasy
6. Inversion
7. Check - list (or Question Prompter)
8. Attribute Listing
9. Forced relationships
10. Brainstorming
11. Synectics
12. Morphological Analysis
13. Area Thinking

In this article the techniques which, in the writers opinion seem to be most powerful will be described. These are (a) Analogy, (b) Empathy, (c) Inversion, (d) Check-list, (e) Brainstorming, (f) Morphological Analysis.

(a) ANALOGY

This is applied when someone is looking into other situations which have features in common with the problem at hand such as in nature, literature, art, other fields of engineering e.t.c. For example Buckminster Fuller got his idea of the geodesic dome by observing sea-urchins and Alexander Grahamm Bell his idea for a phone from studying the human ear.

(b) EMPATHY

This is a method in which the designer imagines him / her self as being a part of the device or product or system to be designed. A typical example is as follows:

How can we get the meat out of walnuts? Using this technique one might imagine him/ her self being the meat inside the walnut trying to get out. This can be achieved by bursting the shell outwards. Thus use compressed air!

(c) INVERSION

- See the inside from outside and vice-versa.
- Change the orientation of parts or the system: up, down, horizontally, its angle.
- Change the roles of the moving parts.

e.g A washing machine could be inverted by having the drum rolating about a vertical axis instead of horizontal.

(d) CHECK— LIST

This was originally developed by Alex F. Osborn. This techique involves a number of questions to be investigated during the creativity phase. These are:

Adapt: What else is like this? What other idea does this suggest? Does the past offer any parallels? What can I copy? Who can I emulate?

Modify: Is there a new twist? Can I change the meaming, color, motion, sound, odor, form, or shape? Are there any other changes?

Magnify: Can I add more time, greater frequency, more strength, more height, more length or more value? Can I duplicate, multiply or exaggerate?

Minify: Can I subtract, condense, lower, shorten, lighten, omit, streamline, split up, or understate?

Substitute: Who or what can I replace? Are there other suitable ingredients, materials, processes, or approaches?

Rearrange: Can I interchange components? Can I use another pattern, layout, or sequence? Can I transpose cause and effect? Can I change the pace or schedule?

Reverse: Can I transpose positive and negative? How about opposites? Can I turn something backward or upside down?

Combine: Can I make use of a blend, an alloy an assortment or an ensamble? Can I combine units, purpose, appeals, or ideas?

(e) BRAINSTORMING

This is a technique applied by a group of people. It has been originally developed by A.F. Osborn in 1939. This method is usually very effective provided certain rules are followed. A chairman of the session is elected who assures that the rules are followed. The rules are:

1. **Critisism is not allowed.** Any attempt to analyze reject or evaluate ideas is postponed until after the brainstorming session. The idea is to create a supportive environment for free flowing of ideas.
2. **All ideas brought forth should be picked up by the other people present.** Individuals should focus only on the positive aspects of ideas presented by others. The group should attempt to create chains of mutual associations that result in a final idea that no one has generated alone. All output of a brainstorming session is to be considered a group result.
3. **Particulars should divulge all ideas entering their minds without any constraint.** All members of the group should agree at the outset that a seemingly wild and unrealistic idea may contain an essential element of the ultimate solution.
4. **A key objective is to provide as many ideas as possible within a relatively short time.**

(f) MORPHOLOGICAL ANALYSIS

This method was originally developed by Fritz Zwicky of California Institute of Technology. In this technique, the primary parameters or attributes of the design problem are identified and for each parameter, a number of alternative possible solutions are considered. A design solution is obtained by choosing one of the alternatives for each of the parameters. Thus a matrix is formed which could easily result in hundreds of possible solutions. Even though most of these will be unrealistic, some might prove to be interesting.

As a simple example the morphological analysis is here applied to a central heating problem. Identifying as important paramenters the (i) type of fuel (ii) method of heat distribution, we can form a matrix as shown in figure 2. Thus we have 8X6=48 possible solutions to the problem.

Figure 2.

DISTRIBUTION / FUEL	AIR	WATER	OIL	STONES	ELECT WIRES	ANIMALS
GAS						
OIL						
COAL		X				
NUCLEAR						
EARTH						
SUN						
BIOLOGICAL						
WOOD						

Bibliography

1. Osborn, A. F., "Applied Imagination" New York, Charles Scribner's Sons.
2. Taylor, C.W., and BARRON, F., "Scientific Greativity - Its Recognition and Development". New York, J. Wiley, 1963.
3. Taylor, C W., "How to Create New Ideas". New York, Prentice Hall.
4. Algar, J. R., M. and Hays, C.V. "Creative synthesis in Design", Prentice Hall, NewJersey 1964.

From "machine design"

5. E. Crossley, "A systematic Approach to Creative Design", M.D. March 6, 1980.
6. E. Crossley, "A shorthand Route to Design Greativity", M.D. April 10, 1980
7. E. Crossley, "Make Science a Partner in your Design" M.D. April 24, 1980
8. E. Raudsepp, "Greativity Games" M.D. July 24, 1980
9. B. Gordon, "Putting Innovation on Tap" M.D. December 11, 1980
10. E. Raudsepp. "Maximizing your Potential for Creativity" M.D. February 26, 1981
11. E. Raudsepp, "Stimulating Creative Thinking" M.D. June 9, 1983
12. M. Dick, "Creative Problem - solving for Engineers" M.D. February 7, 1985

USE OF STATISTICS IN QUALITY CONTROL

by C. K. Tavrou . BSc
Lecturer, H.T.I.

As in so many other areas, statistics play a major role in the process of Quality Control. Either due to the large number of components to be tested, or due to the nature of the test required, the components cannot all be tested but the decision has to be based on the results from a sample test. In all cases though, the chances for making the wrong decisions are known and are acceptable by the parties concerned.

This article will cover some statistical methods used for controlling the quality of a product through all the stages of production. These may be classified as:

(i) Inspection of incoming raw material
(ii) Inspection through the production process.
(iii) Final ispection.

(i) Incoming Inspection

This is carried out on raw material or semi-finished components as they enter the factory, to avoid any defective material from entering the production process, since it will be more expensive to detect and overcome at a later stage.

The most certain method to ensure that the minimum number of defectives enter the factory would be by 100% inspection. However, this is not possible since the costs would be very high in cases of high numbers of components (1000 or more). In the cases of destructive testing is also not possible to test all the components. Therefore a sample is picked up at random and using statistics, it is decided whether a lot should be accepted or not. It must be noted that even 100%, inspection will not ensure that 100% good material enters the factory due to human errors.

Incoming inspection is done either by single sampling, double sampling or multiple sampling plans.

(a) For a single sampling plan, one sample, say n=100 components, is picked at random from a lot, say N=2000 components, and if a number of components, say c=3, or less are found defective, the lot is accepted otherwise rejected since it contains a higher percentage of defectives than the acceptable level.

Since the above is based on statistics, there is a risk that the results of the test may lead to the wrong conclusions. This risk can be found by using the "Operating Characteristic" (oc) curve for the specific sampling plan. This graph relates the Probability of a lot to be accepted, to its content of defectives expressed as a percentage. Figure 1 shows the probability of acceptance of a lot N=2000, n=100, c=3, if it contains defectives from 0% to 8%. For example, if the lot has 1% defective, the lot has a 97% chance to be accepted, if it has 5% defectives the chance for the lot to be accepted is 25%.

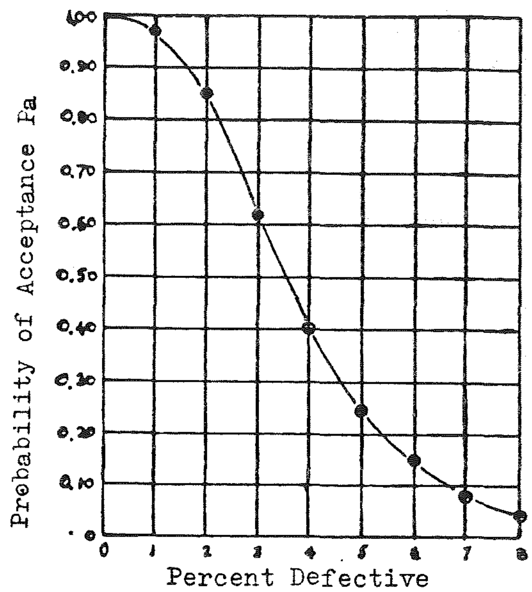


Fig. 1

The calculations for determining the values of the OC curve, are based on the Poisson distribution which gives a good approximation for acceptance sampling, when the sample is at least 16, the lot size is at least ten times the sample size and percent defectives less than 10%.

(b) For a double sampling plan two samples are required. If from the first sample, the number of defectives are found less or equal to C_1, say 2 defectives, then the lot is accepted. If the defectives found are more than C_2, say 4, then the lot is rejected, and if the number of defectives found are more than C_1 and less than C_2, then a second sample is taken and if the total number of defectives found from the first and second samples is less than C_3, say 5, then the lot is accepted, otherwise rejected.

(c) For a multiple sampling plan, more than two samples are taken and the procedure followed is the same as in double sampling. A maximum number of seven samples may be taken.

The above procedures are useful to the supplier and buyer, since they may agree on the highest limit of percent defectives acceptable in a lot, and since they may also agree on the risks involved as shown by the OC curve, they will only need to carry out inspection by sampling which reduces the costs considerably. The sample size and acceptance number are decided by the acceptable quality level and with the use of British or other standards.

(ii) Inspection through the production process

In this case, statistics are used to detect whether a process is under control which is indicated by a control chart. The chart has the statistical control limits of the process and assuming that all the measurements are within the limits, then the variations occur due to chance causes. However, if one point falls outside the limits, then the process is out of control in which case has to be stopped and investigated.

For most control charts, the control limits are calculated on a basic of the values $\bar{x} \pm 3\ \sigma$., where x is the average value of the products tested and σ is the standard deviation. This means that if random causes are present only, then 99.74% of the values on the chart will fall within the control limits. Therefore if any values fall outside the limits, it is considered certain that it happens due to assignable causes.

There are two types of control charts,

(a) Control charts for variable data
(b) Control charts for attribute data

Variable data refers to those concerned with numerical measurements like length, weight, strength etc.

Attribute data refers to those countable quantities like number of defective products, percentage rejects etc.

The most common valiable control chart is the $\bar{x}$—R chart, which is a combination chart of the average of smal samples $\bar{x}$, and the ranges, R (R = x max — x min), of the same samples. The charts are drawn as shown as in Fig. 2.

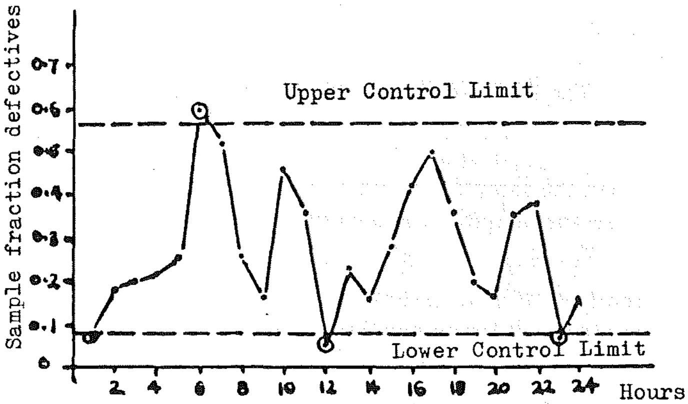


Fig. 2

The average values alone do not give a reliable indication since it is possible for wide ranging values outside the control limits to give an average value within the limit. This can be avoided by plotting the range value R for each average value as shown in fig. 2. The centre line and limits of the charts are calculated from a set of results taken at the begining of the process.

In some industrial situations it may not be feasible to take measurements, but may only be possible to separate good components from bad ones. For example in cases of painted components, castings etc. For these cases, the control charts are plotted using the fraction defective in a sample taken. The limits of the chart is also the 3 σ value. Fig. 3 shows the P-charts.

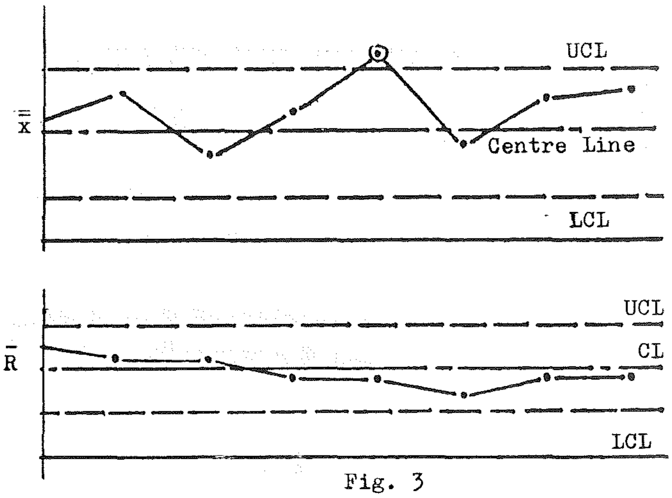


Fig. 3

Other charts are also used for variable or attribute data which may be more suitable for special situations, however, the principle is the same as above using the $\pm 3\ \sigma$ control limits.

(iii) Final inspection

This inspection is carried out before the products are sent to the buyer. The inspection here is carried out by sampling in the same manner as the incoming inspection. It is only logical that this is similar to the incoming inspection, since the products leaving the factory will go through the incoming inspection of the buyer, therefore their quality is checked with the same methods to ensure that they will not be rejected.

This article mearly touched the subject of "Statistics used in Quality Control" but nevertheless, their importance to the subject is clearly shown, as well as their practical application. Numerous text books are available which present explicitly the theory and use of statistics for better product quality.

THE DISTRIBUTION OF ELECTRICITY IN THE INDUSTRY OF CYPRUS

By E. Michael, BSc (Eng.)
Lecturer HTI

1.0 Introduction

In consideration of the application of any electricity conservation measure in the industrial sector a detail knowledge of the distribution of the electrical energy is essential because:-

(i) the electricity intensive industrial subsectors and corresponding consumer groups are identified.
(ii) the dominant forms of end utilisation of electricity are established.
and (iii) the evaluation of the impact on the energy consumption of any measure can be realised.

Towards these aims we provide in this article an analysis of the distribution of electricity in the industrial sector based on the consumption records of the Electricity Authority of Cyprus for the years 1981 to 1983. A further analysis towards the end use of electricity is provided through the analysis of the installed load records of selected representative industrial units. The KVA capacity of their electrical apparatus are divided into eleven end utilisation codes which thus provide an accurate picture of the distribution of the electrical energy in the industry of Cyprus.

2.0 The distribution of electricity

The consumption of electricity in Cyprus is divided into four major sectors shown in Table I below:-

TABLE 1. The distribution of electricity in Cyprus

SN	Sector \ Year	1981		1982		1983	
		KWHx10^6	%	KWH×10^6	%	KWH×10^6	%
1.	Domestic	191.66	26.2	205.86	26.57	228.45	28.4
2.	Commercial	254.36	34.8	274.07	35.38	278.1	34.6
3.	Industrial	242.76	33.22	246.86	31.87	243.94	30.4
4.	Irrigation	42.1	5.76	47.9	6.18	52.92	6.6
	Total	730.88	100	774.69	100	803.41	100

The industrial sector therefore shows a consumption which amounts to approximately one third of the total electrical energy demand. This energy is divided into distinguishable industrial subsectors which are then divided into consumer groups where similar manufacturing industries are grouped together.

Table 2 presents the electricity intensive industrial subsectors together with the corresponding dominant consumer groups. Representative industries from such consumer groups have been selected for analysis of their installed load capacities the results of which are presented in the subseguent sections. The Cement and the Refinery consumer groups have not been analysed due to their huge load capacity which would dramatically influence the results of the remaining industry.

TABLE 2.
Electricity intensive industrial subsectors and dominant consumer groups

S.N	Industrial subsector	percent consumpt 1983	Dominant consumer groups
1.	Mining	7.9	Asbestos mining
2.	Non mettalic mineral products	41.7	Clay products, stone products cement production
3.	Manufacture of Food	12	Dairies, Grain mill and bakery, Sugar products, Food stuffs
4.	Beverage Industries	4.9	Breweries, Tobacco
5.	Textiles and Leather products	5.6	Mannufacture of textiles, Textile goods, Sewing of wearing apparel, Leather footwear, Manufacture of leather
6.	Wood products	3.5	Wood mills, Furniture
7.	Paper and printing	3.2	Paper and paperboard, Printing and publishing
8.	Chemicals	4.5	Basic industrial chemicals, Pesticides, Toilet products
9.	Petroleum products	4.8	Refinery
10.	Rubber and plastics	6.2	Tyre, plastics
11.	Electrical and Mechanical products	4.2	Electrical products, Fabricated metal, Fabricated Wire, Metal Furniture, Structural Metal, Aluminium products.

3.0 The and utilisation of electricity

In consideration of the complete absence of information as regards to the consumption of electricity by the various electrical apparatus used in industry we provide an analysis of the installed KVA load capacity of representative industrial units. In this respect the electrical loads are divided into the following eleven end utilisation codes:-

(i) Code 101:- A.C Motor drives
(ii) » 102:- A.C Compressors
(iii) » 103:- A.C Fans
(iv) » 104:- A.C Pumps
(v) » 105:- A.C Refrigerators and air-conditioners
(vi) » 106:- D.C Motors
(vii) » 107:- D.C Supplies
(viii) » 108:- Heating
(ix) » 109:- Lighting
(x) » 110:- Office eguipment
(xi) » 111:- Others

Table 3 shows the analysis of the load of 35 representative industrial units suitably selected from the dominant industrial subsectors and consumer codes as explained previously. In view of this information the first five end utilisation codes representing A.C. electric motors correspond to the major form of electrical load which amounts to 87.9% of the total load capacity. Further analysis of each one of these codes is presented in the subsequent sections.

From the remaining codes those of electric Heating, Welding and Lighting are distinguishable and represent all together a total load of 9% . The other four codes are insignificant as their total load capacity amounts to 3.1% only.

TABLE 3. **Analysis of the installed load of representative industries.**

Total installed load:- 25852 KVA,

Code	101	102	103	104	105	106	107	108	109	110	111	112
Installed Load(KVA)	15134	2074	3455	1799	408	81	239	942	719	681	164	163
% Load	58.5	8	13.4	6.9	1.6	0.3	6'0	3.6	2.9	2.6	0.6	0.6

4.0 Analysis of the load due to the A.C. electric motors

As it has been revealed previously the A.C electric motors in the industry of Cyprus consititute the major form of electrical load. In this respect further analysis is provided aiming in the identification of the dominant motor sizes in each case. For this reason the A.C. motive power has been divided into nine motor ranges as follows:-

(i)	Single phase motors		(Code 201)
(ii)	Three phase motors	upto 1HP	» 202
(iii)	» » »	1— 3HP	» 203
(iv)	» » »	3—5HP	» 204
(v)	» » »	5—10HP	» 205
(vi)	» » »	10—20HP	» 206
(vii)	» » »	20— 30HP	» 207
(viii)	» » »	30—50HP	» 208
(ix)	» » »	over 50HP	» 209

Table 4 shows the overall results of the analysis of the A-C motors into the above nine motor ranges

TABLE 4: A.C motors by range

Total A.C. Motor load:- 22864.3 KVA Total number of a A.C Motors:- 4395

Code	201	202	203	204	205	206	207	208	209
KVA load	701	836	2627	1619	2709	2528	2486	1180	8178
% KVA load	3.1	3.7	11.5	7.1	11.9	11.1	10.9	5.2	35.8
Number of Motors	994	1139	1098	378	369	175	116	32	94
% Number of motors	22.6	25.9	25	8.6	8.4	4	2.6	0.7	2.1

4.1 Mechanical Drives

This type of load is due to the A.C electric motors utilised for conveyors, belt driven mechines, machine tools, mechanical presses, drilling and cutting machines, mills, crashers etc. Table 4.1 shows the analysis of these electric motors by range. In view of this information it is moted that:-

(i) The majority of these motors (74%) are small single phase and three phase motors upto 3HP rating.

(ii) The major load capacity however (72.4%) is due to the larger motors above 5HP.

TABLE 4.1 Mechanical Drives by motor range

Installed load:- 15134 KVA, Number of motors: 3064

Code	201	202	203	204	205	206	207	208	209
KVA load	362	674	1935	1219	1839	1530	1430	729	5416
% KVA load	2.4	4.5	12.8	8.1	12.2	10.1	9.5	4.8	35.8
Number of motors	549	885	833	284	246	112	71	20	64
% Number of motors	17.9	28.9	27.2	9.3	8	3.7	2.3	0.7	2.1

4.2 Compressors

The compressors are an essential load for every industrial unit meeting the requirements for compressed air. Table 4.2 shows the analysis of this load into the various motor ranges which reveals the following conclusions:-

(i) The major part of the compressor motors (60%) are wedium size units in the range of 1—20HP

(ii) The higher load capacity (63.1%) is due to the larger motor ratings above 20HP

TABLE 4.2 Compressors by motor range
Installed load:- 2074 KVA, Number of motors:- 144

Code	201	202	203	204	205	206	207	208	209
KVA load	7.5	8.3	65.6	50	170	459	690	120	503
% KVA load	0.4	0.4	3.2	2.4	8.2	22.1	33.3	5.8	24.3
Number of numbers	7	12	24	12	24	26	29	3	7
% Number of motors	4.9	8.3	16.7	8.3	16.7	18.1	20.1	2.1	4.9

4.3 Fan type load

The fan type load is due to electric motors utilised as extractor fans, blowers, burners, vacuum pumps etc. Table 4.3 shows the analysis of these motors in to the various motor ranges in view of which the following comments are made:-

(i) The number of the single phase fans constitute the larger range ratio (35.4%)

(ii) There are also many small three phase units with ratings upto 3HP (46.3%)

(iii) Due to the small ratings of the above motors their capacity is minimum and the major electrical load utilised for fanpurposes(58.7%) is due to the larger units with ratings above 50HP. Such motors are used mainly in the large Asbestos mines.

TABLE 4.3 Fan type load motor range

Installed load :- 3455 KVA , Number of motors:- 557

Code	201	202	203	204	205	206	207	208	209
KVA load	52.8	80.7	315.8	114	174.3	241.6	185.6	260.8	2029
% KVA load	1.5	2.3	9.1	3.3	5	7	5.4	7.6	58.7
Number of motors	197	146	112	26	24	18	8	7	19
% Number of motors	35.4	26.2	20.1	4.7	4.3	3.2	1.4	1.3	3.4

4.4 Pumps

This form of end utilisation of electricity is due to the water and the hydraulic pumping load demands of the industrial establishments. Table 4.4 shows the analysis of this load into motor ranges which reveals the dominant presence of small size motors upto 10HP driving the pump type loads.

Table 4.4. Pumps by motor range

Installed load: 1792 KVA, Number of motors:- 406

Code	201	202	203	204	205	206	207	208	209
KVA load	27.5	68.5	279.2	212.4	505.1	282	118.9	69.7	228.4
% KVA load	1.5	3.8	15.6	11.9	28.2	15.7	6.6	3.9	12.8
Number of motors	53	86	116	50	72	18	5	2	4
% Number of motors	13.1	21.2	28.6	12.3	17.7	4.4	1.2	0.5	1

4.5 Refrigeration and Air-conditioning

The electric motors driving the refrigerators and the air-conditioning units are analytically presented in Table 4.5. In view of this analysis it becomes evident that the major part of this load is due to a vast number of single phase motors which are found on refrigerators, water coolers and office air-conditioners. Some larger three phase motors are present usually used to operate central air conditioning systems, which are however rarely used in the local industries.

TABLE 4.5 Refrigerators and air-conditioners by motor range

Installed load:- 408, Number of motors :- 224

Code	201	202	203	204	205	206	207	208	209
KVA load	252	4.1	31.6	23.2	21.1	14.7	61.6		
% KVA load	61.7	9.8	7.7	5.7	5.2	3.6	15.1		
Number of motors	188	10	13	6	3	1	3		
% Number of motors	83.9	4.5	5.8	2.7	1.3	0.5	1.3		

5.0 Conclusions

In this article a detailed analysis of the utilisation of the electrical energy in the industrial sector of Cyprus has been provided. The information presented identifies the electricity intensive consumer groups and the dominant form of end use of electricity. In this respect the A.C motor drives in the industrial sector represent the major form of electrical load which amounts to 88.4% of the total installed load capacity.

Form the analysis of the motive power into motor ranges it becomes evident that there is a vast number (73.5%) of small single phase and three phase motors upto 3HP rating The demand however of the larger motor ranges above 10HP is significantly larger (63%) than the load of the samller ranges (18.3%).

Considering the results of this analysis the application of any energy conservation measure aiming at the higher motor ratings will contribute significantly larger energy savings than if it were to be applied for the smaller motors. Furthermore such measure will require a smaller number of devices to be purchased.

References : Electricity Authority of Cyprus consumption and installed load records.

ENERGY EFFICIENT LIGHTING

By S. Savvides T. Eng. M.I.Elec. I.E.
Senior Instructor, H.T.I.

ABSTRACT

Energy conservation techniques applied to lighting installations can result in significant savings in energy without reducing lighting standards. Although new lighting installations are designed to incorporate energy savings, many existing schemes are lacking in terms of energy efficiency. Opportunities exist to improve lighting standards by using modern equipment and techniques with the added benefit of lower energy consumption.

1.0 INTRODUCTION

1.1. Light

Light is a form of energy. The light obtained from the sun is considered to have a white colour. Actually if a beam of the sun light is passed through a glass prism and is projected on a white screen we see that this composed of different colours. (figure 1).

The colours that are seen by the human eye (visible spectrum) are within the wavelengths of 0.4 μm to 0.75 μm.

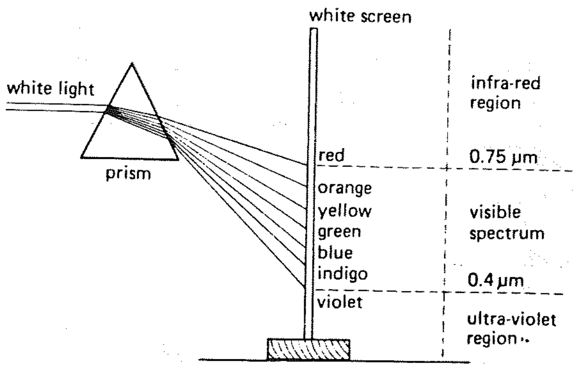


Figure 1: The light spectrum

The response of the human eye in the various colours is shown in figure 2. Looking at figure 2 we see that the human eye is most sensitive to the green and yellow / orange wavelenghts...

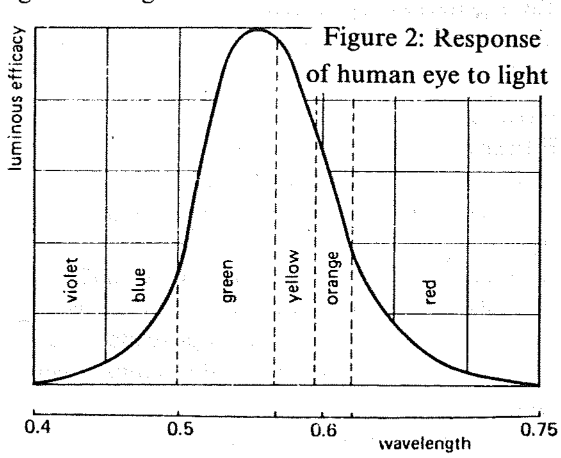


Figure 2: Response of human eye to light

1.2 DEFINITIONS

The following definitions shall be considered when dealing with a lighting installation.

Luminous flux (φ)

The flow of light measured in Lumens

Illuminance (E)

The amount of light in Lumens falling on unit area i.e. lm/m^2 =Lux

Light loss factor (LLF)

The ratio of the illuminance produced by the lighting installation at some specific time to the illuminance produced by the same installation when new. The LLF is the product of three other factors, the Lamp Lumen Maintenance Factor (LLMF) the Luminaire Maintenance Factor (LMF) and the Room Surface Maintenance Factor (RSMF). The LLMF is affected by the aging of the lamp and the LMF and RSMF are affected by the accumulation of dust on the luminaire and the room surfaces respectively. The LLF is expressed as a decimal

Utilisation Factor (UF)

The ratio of the total flux received by the surface to be illuminated to the total lamp flux of the installation.

Luminaire

A lighting fitting

Efficacy

Is the ratio of luminous flux (in lumens) to the power consumed (in watts) of a lamp and is given in lumens/watt.

Colour rendition

A general expression for the colour appearance of objects when illuminated. The expression "Good colour rendering" indicates similarity of appearance to that in daylight conditions.

Control cear

Apparatus such as ballasts, igniters, starters, etc used for discharge lamps.

2.0 THE CHOICE OF LIGHT SOURCE

2.1 General

If a new lighting installation is designed or an existing installation is to be modified the designer must have in mind the various types of lamps available and their chatacteristics so that the correct selection is done.

There are two main types of electric lamps the INCANDESCENT and the DISCHARGE.

2.2. INCANDESCENT LAMPS

In this type of lamp light is produced by raising the temperature of a tungsten filament to incandescence

These lamps can be found in two main categories.
— The TUNGSTEN FILAMENT and
— The TUNGSTEN HALOGEN

2.2.1 TUNGSTEN FILAMENT LAMP (G.L.S.)

In figure 3 a tungsten filament lamp is shown

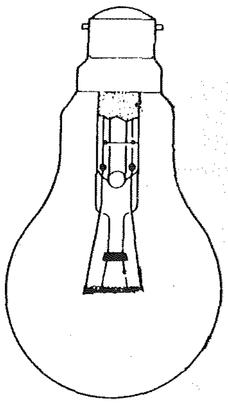


Figure 3. Tungsten Filament Lamp

Operation

Light is generated by a tungsten filament heated to incandescence in a glass envelope usually filled with an inert gas.

Characteristics

- Efficacy: 8—18 lumens/watt
- Average life 1000—2000 hours
- Applications: Particularly suitable for domestic and display lighting
- Easily controlled by dimmers
- Connected directly to the mains voltage
- Good colour rendering
- The lamp attains full brightness immediately wattages from 25W to 1500 W.

2.2.2 TUNGSTEN HALOGEN LAMPS (TH)

Two types of these lamps are shown in figure 4 below.
(a) is a single - ended tungsten halogen lamp and
(b) is a double - ended tungsten halogen lamp

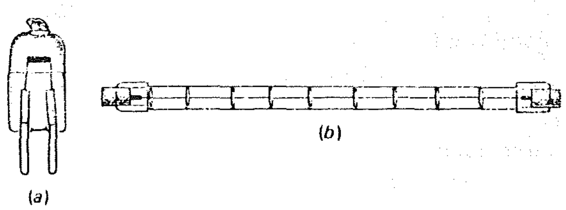


Figure 4: Tungsten Halogen lamps

Operation

Light is generated by a tungsten filament heated to incandescence in a small envelope containing halogens.

Characteristics

- Efficacy: 18—24 lumens / watt
- Average life 2000 —4000 hours
- Applications: flood lighting, display lighting, stage and studio lighting, cine and slide projectors and in automobile head lamps.
- Most of the types can be easily controlled by dimmers
- Connected directly to the mains voltage
- Good colour rendering
- The lamp attains full brightness almost immediately
- Wattages from 20 to 2000 Watts
- The envelope surface is liable to deteriotate if touced with bare hands
- It can be found in low voltages 6V and 12V as well as in 240V.

2.3 DISCHARGE LAMPS

In this type of lamp: light is produced by an electric discharge through a gas or metal vapour or mixture of both.

These lamps can be found in the following main categories.

— the FLUORESCENT which can be found in different types such as:
(i) the ordinary TUBULAR FLUORESCENT and
(ii) the energy saving MINIATURE FLUORESCENT
— the MERCURY DISCHARGE
— the METAL HALIDE
— the HIGH PRESSURE SODIUM and
— the LOW PRESSURE SODIUM

2.3.1 TUBULAR FLUORESCENT LAMPS (MCF, MCFA, MCFE, MCFR)

A tubular flourescent lamp and one of the many wiring diagrams used with these lamps are shown in figure 5.

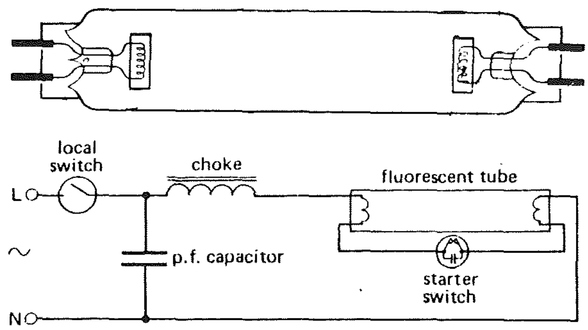


Figure 5: Tubular fluorescent lamp and its wiring diagram

Operation:

Light is genetated by an electric discharge in a low pressure mercury atmosphere contained in a glass tube internally coated with a flourescent material.

Characteristics:

— Efficacy: 37—90 lumens / Watt
(vary with tube wattage, lenght and colour)
— Average Life to 30% reduction in light output 5000- 10000 hours.
— Applications: wide general use for offices, stores, schools industrial buildings, domestic installations
— The dimming of most types is possible by using special circuitry. It is connected to the mains through control gear
— Fair / Good colour rendering

- The lamp attains full brightness very soon after switching on
- Wattages from 4W to 125 W

2.3.2 ENERGY SAVING MINIATURE FLUORESCENT

An energy saving miniature fluorescent lamp and two wiring diagrams for this lamp are shown in figure 6.

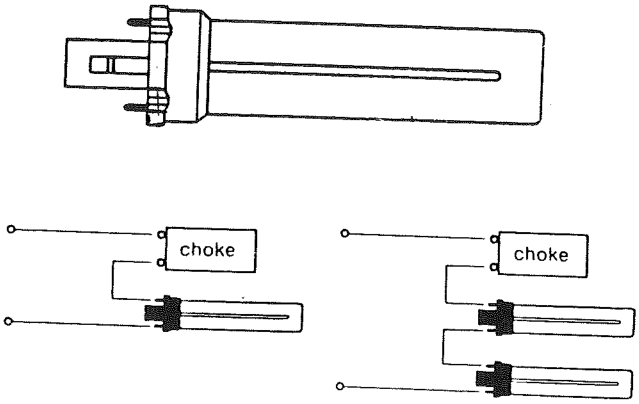


Figure 6: Energy saving miniature fluorescent lamp and its wiring diagrams for single lamp and series pair lamp

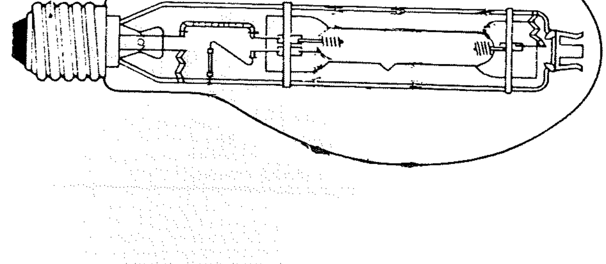
Operation

The light is generated by a low-pressure discharge as in conventional flourescent lamps.

- Efficacy 36—61 lumens / watt
- Average Life 5000 hours
- Applications: Interior and outdoor lighting as well as decorative lighting. It's small size makes it suitable for use in small elegant luminaires. It can replace all types if incandescent lemps in most existing luminaires without major modifications:
- Dimming of these lamps is not possible
- Connected to the mains through control gear
- Very good colour rendering
- The lamp attains full brightness very soon after switching on
- Wattages 5,7,9, and 11 watts. (very soon 18w, 25, w, and 35w lamps will be available in the market).

2.3.3 MERCURY DISCHARGE LAMPS (MBF, MBFR)

A mercury discharge lamp and its wiring diagram are shown in figure 7



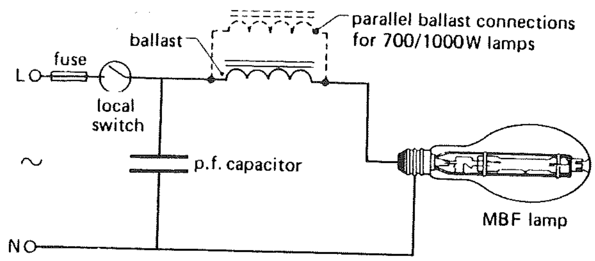


Figure 7: Mercury discharge lamp and its wiring diagram

Operation

Light is generated by an electric discharge in a high pressure mercury atmosphere contained in an are tube within a glass envelope with a fluorescent coating.

Characteristics:

- Efficacy 36—54 lumens / watt
- Average Life to 30 % reduction in light output 5000—10000 hours
- Applications: street lighting, floodlighting, illumination of factories and in some cases offices and shops
- Connected to the mains through control gear
- Fair colour rendering
- The lamp attains full brightness approximately 5 minutes after switching on
- Wattages from 50W to 2000W

2.3.4 METAL HALIDE LAMPS(MBI, MBIF, MBIL)

A metal halide and its wiring diagram are show in figure 8

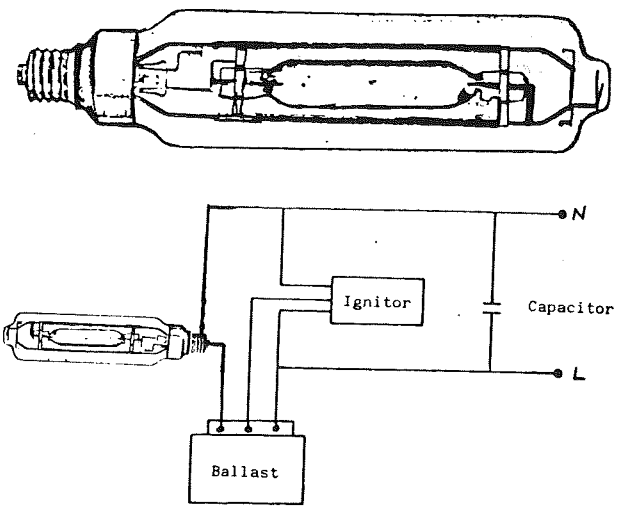


Figure 8: Metal Halide lamp and its wiring diagram

Operation:

Light is generated by an electric discharge in a high pressure mercury atmosphere with metal halide additives in an arc tube sometimes contained within a glass envelope. The outer envelope may have a flourescent coating.

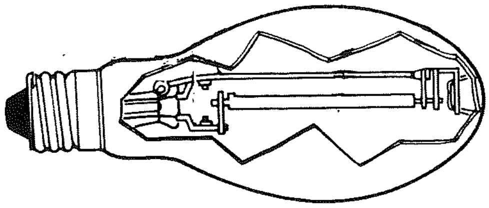
Characteristics

- Efficacy 66—84 lumens / watt
- Average Life to 30% reduction in light output 5000—10000 hours

— Applications: illumination of large office areas, shops and factories where good colour rendering is important. Illumination of exhibition areas and sports complex where live broadcasting of colour television is required.
— Connected to the mains through control gear
— Good colour rendering
— The lamp attains full brightness 2—5 minutes after switching on
— Wattages 400W to 2000W

2.3.5 HIGH PRESSURE SODIUM LAMPS (SON, SON—TD/SON—L, SON—R)

A high pressure sodium lamp and its wiring diagram are shown in figure 9.



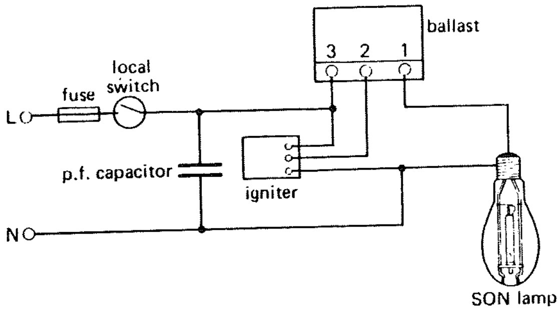


Figure 9: High pressure sodium lamp and its ' wiring diagram

Operation

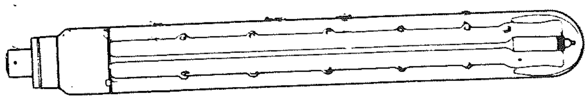
Light is generated by an electric discharge in a high pressure sodium atmposphere, in an arc tube contained in a diffusing or clear outer envelope.

Characteristics

— Efficacy 67—121 lumens / watt
— Average Life to 30% reduction in light output 6000—12000 hours
— Applications: Extensively used in Industrial and Commercial Installations street lighting, decorative floodlighting
— Connected to the mains through control gear
— Fair colour rendering
— The lamp attains full brightness 3—4 minutes after switching on
— Wattages from 250W to 1000W

2.3.6 LOW PRESSURE SODIUM LAMPS (SOX,SLI)

A low pressure sodium lamp and its wiring diagram are shown in figure 10



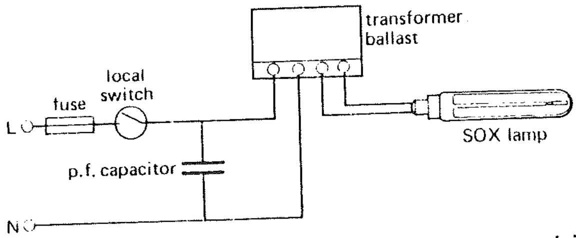


Figure 10: Low pressure sodium lamp and its ' wiring diagram

Operation

Light is generated by an electric discharge in a low pressure sodium atmosphere in a glass arc tube contained in a glass envelope.

Characteristics:

— Efficacy 101—175 lumens / watt
— Average Life to 30% reduction in light output 6000—12000hours
— Applications: Extensively used in road and motorway lighting floodlighting, security lighting and some industrial areas where no colour discremination is required
— Connected to the mains through control gear
— Bad colour rendering
— The lamp attains full brightness 6—15 minutes after switching on
— wattages 35W to 200W

2.3.7 LAMP CAPS

The following are codes used for the various types of lamp caps.

Code	*Meaning*
GES	Goliath Edison screw (E40/45)
ES	Edison screw (E27/27)
SES	small Edison screw (E14/23 X 15)
MES	miniature Edison screw (E10/13)
LES	lilliput Edison screw (E5/9)
BC	bayonet cap (B22/25 X 26) two or three pin)
SBC	small bayonet cap (B15/24 X 17) (double or single contact)
SCC	small centre contact
MCC	miniature centre contact (BA9s/14)
LPF	large pre-focus (P40s)
MPF	medium pre-focus (P28s)
SPF	small pre-focus (P30s)
—	bi-post (G38, four pin type GX38q)
—	medium bi-post (G22)
—	valve base (G17q)
—	medium bi-pin (G13)
—	small bi-pin (G5)

2.3.8 PREFIX USED IN THE U.K TO IDENTIFY DISCHARGE LAMPS

The following is table 3.1 of the CIBS CODE FOR INTERIOR LIGHTING and gives the prefix letters used in the U.K. to identify types of discharge lamps in common use.

Prefix Letters	Description of Lamp
MBF	A high pressure mercury discharge lamp with an arc tube and a fluorescent on the inside of the outer envelope
MBFT/MBTF	An MBF lamp with a tungsten filament in series with the arc tube: a "blended" light source
MBFR	An MBF lamp in which part of the outer envelope has an inner reflecting coating
MBI	A high pressure mercury discharge lamp with metal halide additives in the arc tube and a clear outer envelope
MBIL	An MBI lamp in linear double ended form without an outer envelope
MBIF	An MBI lamp with a flourescent coating on the inside of the outer envelope
MCF	A low pressure mercury discharge lamp with a linear glass discharge tube with an internal fluorescent coating: a tubular fluorescent lamp
MCFA	An MCF lamp with an external conducting strip connected to both end caps
MCFE	An MCF lamp with an extrernal water repellent coating
MCFR	An MCF lamp with an internal reflecting coating on part of the tube
SON*	A high pressure sodium discharge lamp with an arc tube in an outer envelope
SON-TD/SON-L	A linear, double - ended SON lamp with a tubular outer envelope
SON—R	A SON lamp with an internal reflecting coating
SLI	A low prssure sodium discharge lamp with linear arc tube in which arc tube and outer envelope are combined to form one unit(linear construction)
SOX	A low pressure sodium lamp with U shaped arc tube, of intergal construction

* *The SON lamp family is developing rapidly. As new types of SON lamp are introduced, a new prefix letters will be associated with them. The latest edition of the Lighting Industry Federation Factfinder 3: Lamp Guide should be consulted for information on the prefix letters used for SON lamps introduced since the publication of this Code.*

3.0 METHODS OF CALCULATION OF ILLUMINATION

3.1 General

In the design of a new lighting scheme there are a lot of points that must be considered, such as standard recommendations for illumination levels, unwanted glare , maximum use of daylight, the effect of lighting on decoration and furnishings, and colour rendering of objects when illuminated. Having decided about the type of lamp and luminaire to be used for a particular case calculations shall be carried out in order to define the number of luminaires to be used. There are two methods of illumination calculations. The POINT BY POINT METHOD and the LUMEN METHOD.

3.2 POINT BY POINT METHOD

In this method of calculation of illumination level every luminaire is considered as a point or a line sourse. In order to calculate the illumination level at a point the contribution of every luminaire is calculated separately. This method involves a lot of calculations but it can give the exact illumination level at a point. This method is extensively used for the calculation of outdoors lighting such as street lighting playgrounds lighting, tennis courts lighting etc. Due to the complexity and the large number of calculations this method is mostly using suitable computers programmes for the calculations and tabulation of the results. An easier method of calculation of the illumination level at a point is by using the isolux diagrams of the luminairs to be used.

3.3 LUMEN METHOD

With this method the average illumination level at a plane is calculated. It is extensively used for general indoors lighting calculations.

The 'lumen method' formula is

$$N = \frac{E(F) \times A(F)}{F \times n \times LLF \times UF(F)}$$

Where:

E (F) = the average illuminance to be provided on the working plane (lux)
A (F) = the area of the working plane (metre^2)
F = the initial bare lamp luminious flux (lumens)
n = the number of lamps / luminaire
LLF = the light loss factor
UF (F) = the utilisation factor for the plane
((F) - refers to horizontal reference plane)

For the correct application of the 'lumen method' formula information such as the recommended average illuminance for a certain area, the initial bare lamp luminous flux, the Light Loss Factor and the Utilisation Factor for the particular case are required. Recommendations about the average illuminance for various interiors can be found in the CIBS CODE FOR INTERIOR LIGHTING published in 1984. This code is a revision of the 1977 code for Interior Lighting published by the Illuminating Engineering Society.

The following is table 2.1 of the CIBS CODE FOR INTERIOR LIGHTING and it gives examples of activities interiors appropriate for each standard service illuminance.

Standard Service Illuminance (lx)	Charecteristics of the activity interior	Representative activities interiors
50	Interiors visited rarely with visual tasks confined to movement and casual seeing with-out perception of detail.	Cable tunnels, indoor storage tanks, walkways.
100	Interiors visited occasionally with visual tasks confined to movement and casual seeing calling for only limited perception of detail.	Corridors, changing rooms, bulk stores
150	Interiors visited occasionally with visual tasks requiring some perception of detail or involving some risk to people, plant or product.	Loading bays, medical stores, switchrooms.
200	Continously occupied interiors, visual tasks not requiring any perception or detail.	Monitoring automatic processes in manufacture, casting concrete, turbine halls.
300	Continuously occupied interiors, visual tasks moderately easy, i.e. large details 10 min arc and or high contrast.	Packing goods, rough core making in foundries, rough sawing
500	Visual tasks moderately difficult, i.e. details to be seen are of moderate size (5-10 min arc) and may be of low contrast. Also colour judgement may be required.	General offices, engine assembly, painting and spraying.
750	Visual tasks difficult, i.e. details to be seen are small (3-5 min arc) and of low contrast, also good colour judgement may be required.	Drawing offices, ceramic decoration, meat inspection.
1000	Visual tasks very difficult, i.e. details to be seen are very small (2-3 min arc) and can be of very low contrast. Also accurate colour judgements may be required.	Electronic component assembly, gauge and tool rooms, retouching paintwork.
1500	Visual tasks extremely difficult, i.e. details to be seen extremely small (1-2 min arc) and of low contrast. Visual aids may be of advantage.	Inspection of graphic reproduction, hard tailoring, fine die sinking.

2000	Visual tasks exceptionally difficult, i.e. details to be seen exceptionally small (1 min arc) with very low contrasts. Visual aids will be of advantage.	Assembly of minute mechanisms, finished fabric inspection

The initial bare lamp luminous flux must be obtained from the lamp manufacturer. The Light Loss Factor may be calculated. Guidance on the calculation of Light Loss Factor may be obtained from the CIBS CODE FOR INTERIOR LIGHTING 1984 appedix 7. The utilisation factor for a given luminaire may be either derived from tables supplied by the luminaire manufacturer or using tables given in the CIBS Technical Memorandum No 5.

4.0 RULES FOR ENERGY EFFICIENT LIGHTING

Use the most efficient lamps consistent with required illumination levels and colour rendering.

Lighting efficiency is mainly determined by the efficacy of the lamp to be used.

Use the ligh output from lamps efficiently.

Make sure that you get the maximum possible value of the utilization factor for the conditions of your installation.

Maintain lamps and luminaires clear of light blocking dust and dirt.

The accumulation of dust on lamps and lamp reflectors reduced light output while consuming the same amount of electricity. More frequent cleaning may result to reduction in the number of luminaires required, and hence reduction of electricity consumtpion.

Make the best use of daylight

Switching arrangements to be such so that part of lighting may be off when contribution of daylight allows it.

Switch off lights where lighting is not needed.

Use time clocks, or photoelectric cells for the automatic control of lighting.

Outdoor lighting should always be controlled automatically. The same applies to all other areas that this is possible.

Provide light coloured walls ceilings and floors to avoid the absorption of light by the surroundings.

Lighter colours will reflect more light than darker colours.

Replace lamps which have exceeded their rated life.

The light output of the lamp drops considerably when the rated life of the lamp is exceeded while electricity consumption remains the same.

Maintain 'save it' and 'switch-off' notices as an aid to good housekeeping .

Investigate the possibility of the control of lights in special cases from sound-photocell automatic control devices.

Lights will automatically switch off if there is no noise (room not occupied) or if there is sufficient daylight.

A comparative lighting cost analysis shall be carried out before we decide about the type of lamps to be used.

A comparative lighting cost analysis for various lamps shall be carried out before the final choice of lamp to be used.

5.0 ASSESSING THE EFFICIENCY OF AN EXISTING INSTALLATION

It is suggested that the following procedure might be used as a model for assessing the efficiency of a lighting installation and deciding on the action to be taken. The headings of this section constitute an 'Action check list' which can be used as a quide in actual instances.

Date installed

Any installation that is more than 20 years old is in any case probably due for rewiring luminaires will probably have deteriorated and in many cases lamps of higher luminous efficacy will be available.

Check the illuminance

Readings shall be obtained with a Lux meter for the various areas. The average illuminance found shall be checked with that recomended in the latest CIBS code for interior lighting.

Light source and luminaire type

Reflectors of luminaires deteriorate with age and absorb a high proportion of the light output of the lamp. Considerations should be given to changing both lamps and reflectors using more eficient lamps and more modern fittings.

Check the installation and wiring

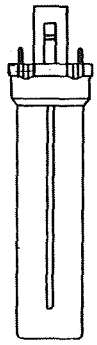
In the case of discharge lamps appart from the deterioration due to dust and dirt power factor capacitors may have become open circuit and consequently 'wattless' current will have increased.

Check flexibility of switching control

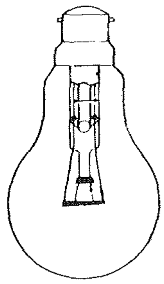
It is common practice to switch lighting fittings in groups determined by easy of wiring. A better plan is to switch groups of fittings near areas which receive natural light separately so that these may be switched off when daylight contribution is sufficient.

6.0 REPLACEMENT OF ORDINARY GLS LAMPS WITH ENERGY SAVING LAMPS COMPARATIVE COST ANALYSIS

A. Energy Saving Lamp (Fluorescent miniature)



B. Ordinary Lamp (Tungsten GLS)



	A. Energy Saving Lamp (Fluorescent miniature)	B. Ordinary Lamp (Tungsten GLS)
1. LAMP WATTS	9W	60W
BALLAST	4W	—
TOTAL LOAD	13W	60W
2. LUMINOUS FLUX	600 LUMENS	575 LUMENS
3. LAMP LIFE	5000 HOURS	1000 HOURS
4. ELECTRICITY CONSUMPTION/HOUR	0.013 kwhr	0.060 kwhr
5. ELECTRICITY CONSUMPTION FOR 5000 HRS	65KWhr	300 KWhr
6. ELECTRICITY CONSUMPTION COST FOR 5000 HRS (7.5c/kwh)	C£4.88	C£22.50
7. LAMP COST	C£3.60	C£0.15
CONTROL GEAR COST	C£1.70	
LABOUR COST	C£2	

Note: Prices quoted above are 1984 prices.

CONCLUSIONS

1. With 9W Fluorescent Lamp a saving of the order of 80% is achieved.

2. In 1500 hrs of operation of the fluorescent fitting the saving cover the additional cost of the lamp and the modification

5 hrs/day	Payback period	10 months
10 hrs/day	Payback period	5 months

3. In 1000 hrs of operation of the fluorescent fitting the saving cover the additional cost of the lamp

5 hrs/day	Payback period	$6^1/_2$ months
10 hrs/day	Payback period	$3^1/_4$ months

4. This change is recomended for luminaires operating 5 hrs/day or more.

5. In addition to the energy saving achieved by the use of the energy saving miniature fluorescent lamps a considerable reduction in the maximum demand of the electrical Installation may be achieved. If a total of 200 lamps of the above type is replaced by an equivalent number of incandescent lamps then the reduction in maximum demand will be

$$60W \times 200 — 13W \times 200 = 12KW — 2.6KW = 9.4KW$$

If we consider that the power factor of the miniature fluorescent lamps is improved to 0.95 then a reduction in the maximum demand of the installation of the order of 1OKVA may be achieved.

REFERENCES

1. Electrical Installation Technology 2 M.L. Lewis.
2. Energy Management and good lighting practices, department of Energy U.K.
3. CIBS code for interior lighting 1984
4. Commercial catalogues of lighting fitting manufacturers.

TECHNICAL APPRAISAL OF INDUSTRIAL PROJECTS

By Louis Loizou BSc
Management Consultant
Coopers & Lybrand

DEFINITION: The quantitive and qualitative appraising of all planned inputs against the projected outputs.

INTRODUCTION

A large number of projects are doomed to failure due to the fact that they are not appraised in a systematic way. Probably the greatest of all fallacies, in this field, is the narrow minded approach which capitalises on the mere examination of financial projections.

It is imperative when looking at a proposed industrial project to try and visualise the end result and simulate all the necessary activities. It helps if three main project classifications are born in mind a) new projects; b) replacement projects; c) expansion projects.

The prerequisits

Whatever the nature of the project, four items are required to operate it successfully. These are:

(a) Materials
(b) Machines
(c) Men
(d) Money

From this classification it is obvious that money is only one out of the four necessary prerequisits in an industrial project.

Our target therefore, is to scrutinize all the above prerequisits and make sure that they satisfy the projects requirements both qualitatively and quantitatively.

Upon embarking on the technical appraisal of an industrial project it is of paramount importance to maintain an open eye policy. The technical analysis is fairly wide, covering a number of interlinked aspects. For example, the raw material content often determines technology which in turn may determine location. Location, however, may have a different effect on raw materials and so on.

MATERIALS

Once the end product or product mix have been established, it remains for the materials to be determined. Many times the availability and form of the raw materials may affect both the process to be used and the form of the product. Raw materials can be analysed, through classification and characteristics.

Classification of raw materials

1. Raw Materials

(a) agricultural products
(b) Livestock
(c) Marine products
(d) Minerals

2. Processed Production Materials and components

(a) Base metals
(b) Processed intermediaries
(c) Manufactured parts

3. Auxiliary Materials and Factory Supplies

(a) Auxiliary materials
(b) Factory supplies

4. Utilities

Characteristics of raw materials

1. Qualitative properties

(a) Physical properties
(b) Mechanical properties
(c) Chemical properties
(d) Electrical properties

2. Sources and quantities available

eg. seasonality
reliability of supplies - imports

3. Unit price

The form of the material should be investigated against other factors
eg. machines and equipment to be used, processes, water, etc.

MACHINES

Again the selection of machines will depend upon the raw materials available and the end product or product mix. In this context, the term "machines" is used to denote all the machinery, plant and istallations, instrumentation and all process conveying and transport equipment. These may be presented as follows:

Machines

1. Plant and installations

(a) Power
(b) Water
(c) Air
(d) Other (for example fans - extractors)

2. Machinery

Used to manufacture materials into Finished Goods

(a) Mechanical
(b) Electrical
(c) Pneumatic

3. Instrumentation and Control

Control room of power stations - process plants
Necessary - essential equipment

4. Process conveying and transport equipment

(a) Forklifts
(b) Conveyor belts
(c) Other conveyors
(d) Hoists (overhead)

5. Other plant and machinery

Custom made for the specific industry

6. Auxiliary equipment

(a) Jigs
(b) Fixtures
(c) Moulds + patterns
(d) Tools

used to make the job either possible or easier.

Selection of equipment

The selection of equipment and technology are interdependent. In certain projects technology and equipment are part of the same arrangement. When technology is independently acquired, selection should take due care to secure the following:

(a) the right total and selection capacities
(b) the required infrastructural facilities
(c) sufficient trained personnel for operation and maintenance.

A detailed list of machinery and equipment must be drawn up, covering the requirements of each stage of production, from the receipt of raw materials to the final products. Spare parts and tools must be included as well as provision for transport costs, inflation and delays.

Plant layout

Where the optimum plant layout is not adopted, even if products come out of its end, they will probably be qualitatively inferior and they would have cost more to be produced. Machines are designed to process materials in a certain order i.e. in a uniform flow. It would be a great fallacy to reverse this process. On the other hand, even if the process is not reversed but the machines are not properly placed with respect to each other, then there will be unnecessary inputs of materials handing and transfer which do not add value to the products.

It is important here to bear in mind that the use of process conveying and transport equipment must be considered in terms of cost effectiveness.

Technical

Design stage - selection of equipment

Make sure that the designed or selected equipment to be used in the project are the best possible with respect to the project. For expansion make sure that the new equipment is compatible with the old ones.

Implementation

Make sure that an implementation schedule is proposed. Assess the implementation schedule and make sure that it is correct and that it serves the success of the project. It is desirable that the technical implementation schedule is integrated with the cash flow and controls are available for corrective actions.

Buildings

The process and machines to be used will determine the buildings for the project. Appart from the shop floor area required, due consideration must also be given to the shape and volume of the building. Appraising the building for a project involves the following:

(a) Site preparation and development
(b) Buildings
(c) Outdoor works

MEN (MANAGEMENT AND LABOUR)

Make sure that provision is being made for the right manning and operating of the project. This should encompass all levels and aspects of operations that is Management (Top, Middle and Lower), Administration (secondary services) and Technical.

Examine that:

1. The organisation chart offered will serve the project and job descriptions.
2. The persons selected to fill the vacancies have been properly selected.
3. The given cost of manning the project has been correctly assessed.

When planning personnel requirements, due consideration should be given to the following factors:

(a) A general assessment of the supply and demand of manpower and especially of labour in the area.

(b) An appraisal of manpower and occupational skills available at national and regional levels in view of the skill and technological requirements of the project.

(c) A note of the main provisions of labour legislation covering industrial relations (individual and collective), procedures of recruitment and discharge, as well as wage levels, fringe benefits and their expected annual growth rates;

(d) The number of shifts; and

(e) The number of annual working days.

Provision must be made for the preproductive phase (commissioning), for example training and installing.

Management

Financing organisations are nowadays very critical on the management structure proposed to manage the project. Many projects failed, although very strong on other prerequisits, because of bad management. The international market is becoming very competitive hence very competent management is essential to have good chances of success.

Previous experience in the relevant field is nearly always a must. No resources may be waisted in taking lessons.

Identify:

(a) Job Specification along ladder of hierarchy.
(b) Fill the posts with confident people.
(c) Management information Systems.

Administration Staff

Essential to support both the management and technical staff. For example, typing pool, secretaries, archivists, assistants, etc.

Having examined the above three main inputs, namely materials, machines and men it is desirable to also examine some other general factors that are due to affect these inputs and eventually the project itself. These factors may be looked under the main headings of location and site and project engineering.

LOCATION AND SITE

To start with, a project may have its origin in a desire to take advantage of certain local policies or other factors which lend themselves for a fruitful project. Although sometimes used interchangeably, the term "location" describes a broad geographical region e.g. a town and its surrounding, while "site" describes a specific plot whithin the region. A number of factors affect the decision on where to locate a proposed project. The major ones are listed below:

1. Factors Affecting Location

(a) Public Policies

- Government incentives or penalties
- Zoning
- Government projects
- Industrial estates

(b) Material or Market Orientation

The relative economics of transporting raw materials or selling the final goods may affect the location decision. These factors have become less important over the years because products are generally becoming lighter while transportation has become cheaper and more efficient. There are, however, cases where there is a clear advantage for locating near the raw materials source or in other cases near the market. For example where heavy and bulky minerals are processed, raw material orientation may be an advnantage; alternatively, where the final good is perishable, market orientation may be preferred.

(c) Local conditions

The availability or cost of securing infrastructural facilities are important factors affecting the locational decision.

(d) Other factors

- Labour availability
- Climate
- Entrepreneur's preference

2. Factors Affecting site Selection

(a) Cost of Land
(b) Local Conditions (infrastructure, socio-economic)
(c) Site Preparation and Development.

PROJECT ENGINEERING

It is not normally the case that there are alternatives regarding most aspects of a proposed project, but this is especially so for project engineering. Such alternatives should be sought and investigated carefully. Two points, however, should be borne in mind:

(a) The more complex and sophisticated a product is, the fewer are the suppliers of technology and so the choice element is reduced.

(b) The technology chosen should be proven and relevant, i.e. experimental and obsolite technology should, as a general rule, be avoided, although the merits of each case should be investigated.

MISTAKES MOST FREQUENTLY MADE

1. Insufficient Preliminary Study or Analysis

This can result in higher investment costs than anticipated, delays due to incomplete machinery lists, higher operating costs due to insufficient, or unavailability of suitable raw materials, etc.

2. Failure to Consider Alternatives

This may result in inefficient use of the funds available.

FORECASTING COSTS

For some projects it is easy, whilst for others it may be extremely difficult. The principal ways of forecasting costs are the following:

(a) Reference to Similar Projects

This is a simple and reliable method but rarely possible because of secrecy and probable differences in size and scope.

(b) Information from Suppliers

Use of technical information and the experience of the suppliers can be fairly reliable.

(c) Published Tariffs, Surveys, Regulations

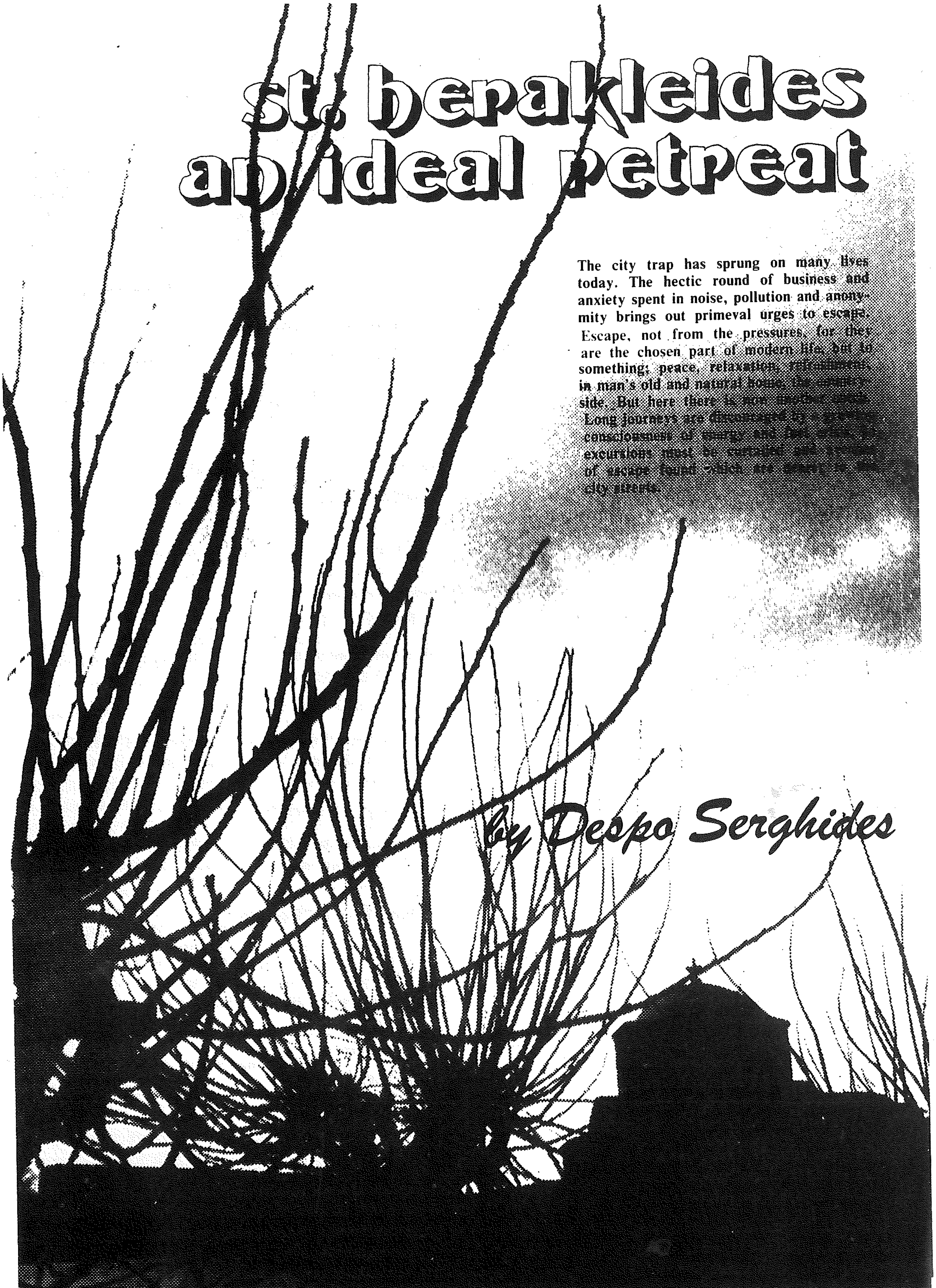
Useful for such costs as unionized labour, taxation, imported raw materials, etc.

(d) Technical Exports

REFERENCES

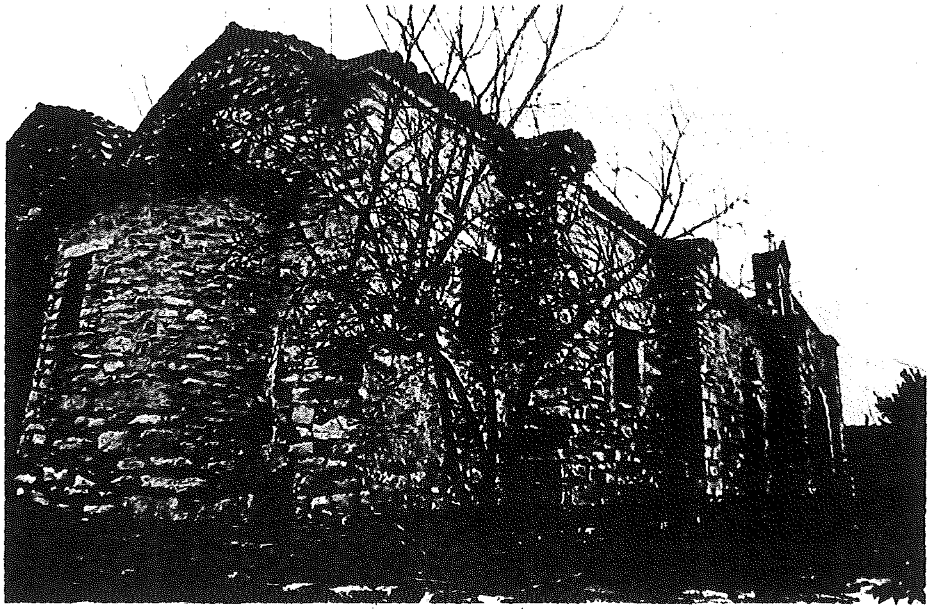
(a) Manual of Industrial Project Analysis — O.E.C.D.
(b) Manual for the Preparation of Industrial Feasibility Studies
(c) Management Consultancy Services Manual — C & L
(d) Lecture notes for M.I.M. Course.

st. herakleides an ideal retreat



The city trap has sprung on many lives today. The hectic round of business and anxiety spent in noise, pollution and anonymity brings out primeval urges to escape. Escape, not from the pressures, for they are the chosen part of modern life, but to something: peace, relaxation, refreshment, in man's old and natural home, the countryside. But here there is now another snag. Long journeys are discouraged by a growing consciousness of energy and fuel crisis, so excursions must be curtailed and avenues of escape found which are nearer to the city streets.

by Despo Serghides



Near to Nicosia there is such a spot; discreet, charming and restful, fourteen miles from the city but a world of time and space away from city life. Resting below the northern slopes of Troodos, at Politiko, stands the convent of St. Herakleides in historic elegance. Politiko is the modern descendant of the ancient kingdom of Tamassos. The town was sacred to Venus and here she grew a tree with golden apples. The site was famous for its beauty even then. Claudian wrote:

> "From here two fountains flow,
> sweet tasting one,
> The other bitter anu with poison
> tinged.
> There Cupid dipped his piercing
> darts of love"

The convent is named after St. Herakleides, the first Bishop of Tamassos, reputedly appointed by St. Barnabas the apostle and famed for his miracle working powers. The skull of the saint is kept in a wooden box on the altar.

Heading south from Nicosia, the urban gives way to untamed land and unspoilt villages. The mountain scenery shifts under changing light and brings new tones and colours to the blue-green hues. From Politiko one faces the convent building, settled in among the silver olive groves; the effect is secluded and protected from the clamour of the outside world, a quiet, religious peace. The builders obviously considered the natural beauty of the site to be as important as the structure itself.

A metalled parking area has been added to the front of the convent. From here one passes under a covered entrance through heavy double doors on which leaf patterns are carved. A graceful arch leads out to an open courtyard. Already one feels the combined senses of austerity and coziness architecturally expressed.

To the right, a long gallery corridor gives access to the convent rooms. Stone columns support carved wooden beams on which the roof of faced tiles and wooden rafters rests. The columns dominate the convent facade, creating graceful divisions of its great expanse. They frame the background whitewashed wall, its low-doors and latticed windows. Behind this elegance the rooms are plain with simple furniture. The garden patio merges sight and sound to form the image of a monastery garden; plants and flowers, birds, splashing of spring water and the murmuring echoes of the visitors' chatter.

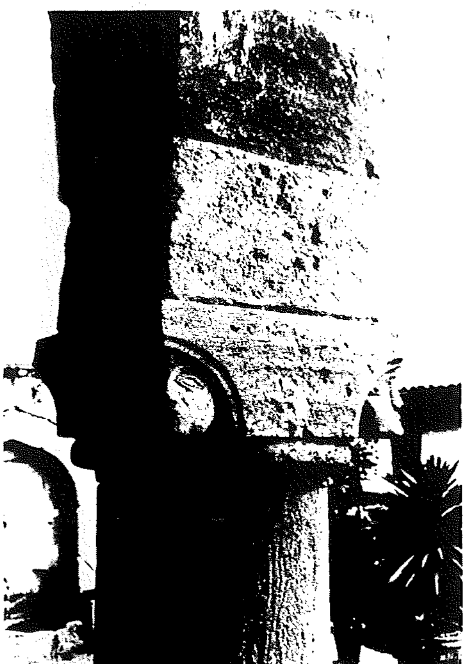
To the south east of the patio stands a medieval chapel and mausoleum, a square building capped with a dome. Beneath the icon screen are the tombs of four Cypriot saints, one the sister of Herakleides. Against the north and south walls lie the two great saints of Tamassos, Herakleides and Mnason, a friend of St. Paul. Information about their lives in hagiographic; some mosaic remnants of the floor indicate that Herakleides was worshipped as far back as the 4th century. Under the floor of hexagonal marble tiles, a hole leads to a cave, probably a Hellenistic tomb but said to have been the first grave of Herakleides.

Near the church are traces of an early (5th century) Byzantine Basilica, some parts of an arch, wall foundations and mosaic floors. It was destroyed around the 8th century and rebuilt in the same style. It survived again until the 14th century and two frescoed pillars to the north are believed to belong to the 11th or 12th century.

The convent was rebuilt by Bishop Chrysanthos in 1759 but when a Russian monk, Basil Barski, visited the site in the early years of that century it

appeared to have been functioning as a monastery for some years. In the 19th century the Church became too poor to support the monastery and it was let to a monk, Kyrillos, for a while. before being abandoned. During 1963 and 1964 the nuns moved in and it became a convent. The nuns have played a major part in the renewal; with zeal and affection they still run it impeccably. The mosaics of the courtyard floor are patiently renewed by them with pebbles gathered from beaches at Limassol, Larnaca and Curium. Designs from the mosaic floors at Paphos are selected, approved by the Department of Antiquities, and incorporated. The idea for the construction of the floor originated from Colonel Athos Myrianthopoulos who has been associated with the convent from childhood. His love for the place has been expressed in much generous help towards its preservation and welfare.

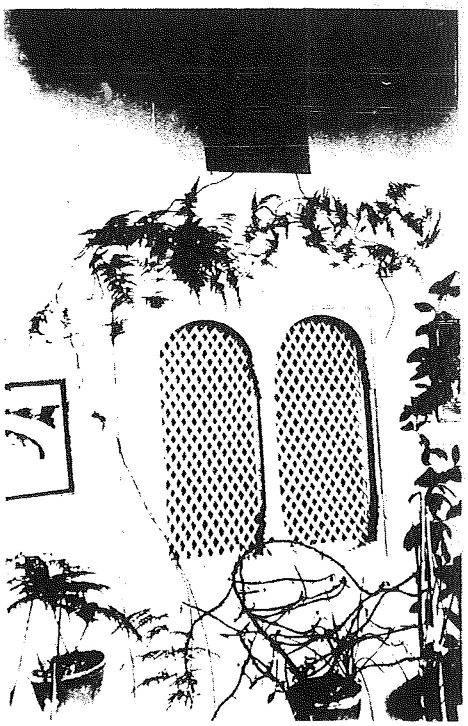
The convent is thriving again today as an exclusively female community. All work is distributed amongst, and carried out by, the nuns. A priest lives in a house nearby with his family and carries out the Divine service, the only part of the mass which the nuns cannot perform under Church law. At present 23 nuns are living in the convent; their habit, a black mourning shawl, is copied from the religous communities of Chios island



with which Cypriot monastery life had some connections. Some nuns of the status Venerable wear the cassock instead. (Venerable is a status reached after three years trial and study and bestowed by the Mother Superior and a Confessor).

The daily routine is strict and disciplined. The nuns rise at 3 a.m. for private meditation. At 4 a.m. Matins are sung for 2 hours after which each nun goes to her task or deaconship. This can be cooking, honey gathering, handicrafts tending the goats and chickens; or humble cleaning and gardening. Lunch is at 11 a.m., in the late afternoon Vespers are sung, then supper at 7 p.m. with scripture reading. At 8 p.m. the nuns withdraw for prayers and sleep. Greek Orthodox fasting is strictly observed; meat is not eaten at all; no oil or animal products are served on Monday, Wednesday, or Friday.

In contrast, the constant flow of visitors brings a contemporary humanistic reference to the place. They seem to blend harmoniously. The everyday style of worldly life is enhanced by the natural values of the religous; the ascetic life of the nuns is given meaning when



referred to the everyday problems of the ordinary people. A more practical result is that the economy of the self-sufficient convent is helped by sales of convent produce; sweets preserved in syrup, almond sweet , (a speciality), plants, and icons. Visitors can also enjoy walks on bridle paths shared only with occasional donkeys, sheep and goats, or hunting for mushrooms and wild vegetables.

Thirty minutes from Nicosia is not a great span of time or distance. In the tranquillity of St. Herakliedes it can seem a great distance; centuries in time, and in space, a distant star. One cannot fail to feel refreshed and clean after contact with such a place. It gives even city life a new dimension.

HTI CALENDAR OF EVENTS
Academic Year 1984-85

by Ms Dena Charalambidou
Lecturer, H.T.I

SEPTEMBER

- Lectures for the academic year 1984—85 commenced on September 10th.
  Four hundred and eighty-five (485) students enrolled on regular courses.
- The Mechanical part-time course continues on its second year with fifteen (15) students.
- The Regional Training Centre held three courses
- Sponsored by WHO: The Hospital Laboratory Specialised, from September to January with six participants. The X Ray specialised course from February to July with seven (7) participants and the Electro-Medical Specialised Course with eleven (11) participants from February to July.
- The HTI Director, Mr G. Christodoulides, and the Head of the Mechanical and Marine Department, Mr G. Iordanou, leave for Sweden to attend a two-week seminar on Maritine Education and Training organised by the International Maritine Organisation at Malmore.
- A new club is announced with the aim of studying and preserving traditional architecture.

OCTOBER

- Classes were suspended on October 1st to celebrate Cyprus Independence Day.
- A part-time course in Energy Enginneering began on October 3rd. Lectures are to be held on Wednesday afternoon. The whole course will be of 150 hours duration.
  The aim of the course is to introduce principles of energy engineering and energy management to engineering techicians, engineers and energy planners. The course began with thirty (30) participants.
  Mr Costas Neocleous, Lecturer Mechanical Enginnering, leaves to attend a course on Thermal Application of Renewable Energies, on an Italian Government fellowship from 1—30 October 1984 held at Catania, Italy.
  Mr Andreas Kyprianou, Instructor Civil Engineering leaves on an Italian Government followship to attend a specialised course for the Woodworking Industry at Remini, Italy, from 1st October 1984—31st July 1985.
  The Self-Instruction Centre resumed its operation in October. It will be open to the public three (3) days per week in the afternoon and evenings.
  HTI staff and students celebrated UNESCO Day on Tuesday, October 30.
  Coaches left HTI premises around 8.00 am and arrived at Lefkara at 9.30 a.m. There a representative of the commnuity outined shortly, the history of the village, its local lace and embroidery, the silver art and other famous crafts. H.T.I basket ball team played against the Lefkara Cymnasium basket-ball team.
  Students and members of staff toured the attractive village of Lefkara admiring its natural beauty and famous handicrafts.
  Around mid-day they left for Ziyi beach where they had lunch at the Ziyiana Restaurant. There they feasted till late in the afternoon when they made their way back to Nicosia.
- The HTI Staff Association organised a party at the Shiestris Tavern to bid farewell to Mr Andreas Constantinou, Lecturer Mechanical Engineering, who would retire on November 1st 1984.
  Mr Andreas Constantinou was appointed in 1968 and he is the first member of HTI staff ever to retire.
  Dr. Andreas Mallouppas left for England and France on 2nd December to attend a course on Electromedical Equipment. He returned on December 21st.

NOVEMBER

- The Safety Committee organised a series of lectures on November 2nd on Artificial Respiration and Basic Principles on First Aids for all first year students and WHO participants.
- On November 28th Mr M. Attalides, P.I.O Representative, gave a lecture on The Problem of Cyprus to HTI overseas students. The lecture was accompanied by the film "Cyprus, the island no one ever forgets!".
- Mid-semester exams were held from 5—9 November.

DECEMBER

- Wednesday December 12th is Environment Day for HTI. Member of staff and students willingly under took various tasks to embelish, clean, paint or tide up the Institute premises and the surrounding grounds.
  A hard day's work ended with some drinks
- Lectures were suspended from 23 December to 6 January for Christmans Festivities.
- On 28 December students and staff had a drink in the students Canteen to mark the Christmans Celebrations and welcome the New Year.
- The Administration staff held a free Souvla Party on December 31st at 11.30 am in Students Canteen. All HTI staff was invited.

JANUARY

- Lectures commenced on 6th only to be suspended again on January 14th for Semester Exams. Lectures are resumed on Monday 28th.
- The Director visited the Luton College of Higher Education and other colleges in Bedfordshire and London between the 20th — 30th January to pro-

mote further the educational links between U.K. and H.T.I. He also discussed matters for the proposed introduction of the course in Computer Studies at H.T.I.

- The Head of the General Studies Department, Mr Demetris Hadjiloizis visited London and Wales between 20th and 30th January 1985 to get information on the proposed Computer Studies for H.T.I. Both were the guests of the British Council.

FEBRUARY

- Mr Stelios Kiliaris, senior officer of the Ministry of Finance, gave a lecture on "Economy of Cyprus" in HTI amphitheatre on Wednesday 6th at 7.30 p.m.
- On Wednesday 13th instructors from the Hotel and Catering Institute gave a lecture to the HTI graduating students on "Table Manners" at 12.15 p.m. in the HTI amphitheatre.
- On February 25th classes were suspended to celebrate Green Monday.
- The HTI Director visited New Delhi, India, from the 21st — 26th February 1985 and took part in a Workshop on Science and Technology Indicators for Development at which he presented a paper on "Science & Technology Statistics / Indicators about Cyprus". The above Workshop was sponsored by the Commonwealth Science Council.

MARCH

- On March 6th the Formal Social Dinner of the graduating students was held at the Philoxenia Hotel, at 8.30 p.m. Members of staff and guests attended.
- On March 23th classes were suspended to celebrate the Greek National Day of Independence.
- An excursion to Troodos was organised by the Welfar Officer, Mrs Frangeskou, on March 30th mainly for HTI overseas students.
- Mid-senester exams were held from 18—22 March
- The Course in Digital Electronics and Microcomputers which started on November 1984, was successfully completed by the end of March 1985 with 32 paricipants from the Civil Service and industry.

APRIL

- On Monday April 1st classes were suspended to celebrate the Cyprus struggle for Freedom.
- Mr Michael Watkins, Course Leader in Computer studies at the Polytechnic of Wales, gave a series of lectures to HTI members of staff and students. Mr Watkins came to Cyprus to help with the design of syllabus and setting of the new Course on Computer studies.
  From 4—10 April Mr Watkins gave a series of lectures mainly on Computer Softwere and Hardware, on Engineering Higher Education in U.K. Mr Watkins also saw and advised students who were interested in studying in U.K.
- Classes were suspended from 10—19 April for Easter Holidays.
- On Tuesday 9th Dr. N. Pavlides gave a short talk on Blood Donation in the Students Canteen at 9.45 a.m. The talk was followed by the award of Diplomas to HTI blood donors. In the end HTI members of staff and students donated blood.
- The Safety Committee organised lectures on Building and Carpentry Works and Metal Works which were given to all first year students and WHO participants, in co-operation with the Safety Department of the Ministry of Labour and Social Insurance. The above lecturs were given on 23 and 26 April during Workshop Training time.
- Wednesday, 24th April, is Sports day, for HTI. The final matches for Football, Table Tennis, Tennis, Volley-ball, Cross Country Running, Basketball, Hand-ball, Badminton, Softball and Seven-A Side were held on Sport Day. The medals, shields and trophies for the above activities were sponsored by KEO Co. LTD.

MAY

- On Wednesday, May 1st, classes were suspended to celebrate Labour Day
- On May 22nd there was a meeting in the afternoon of HTI members of staff and students with the aim of forming a core to set up at a later stage a sub-branch of the Pancyprian Association for the Welfare of the Blind.
  The Pancyprian Association for the Welfare of the Blind is planning to establish Youth sub-branches in the institutions of Higher Education.
- On Wednesday afternnon (22nd May) and Thursday afternnon (23rd May) the finals of Higher Education Sports Tournaments were held
- Final year students began their semester Exams on May 27. Exams are scheduled to end on June 5th.

JUNE

- Semester Exams for first and second year students began June 4. Exams are expected to finish on June 14.
- Final year projects were to be handed in on June 17.

JULY

- The Graduation Geremory will be held on Friday July 5th.