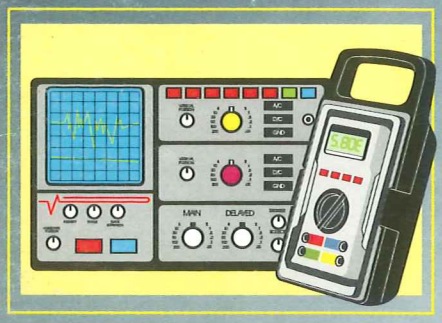
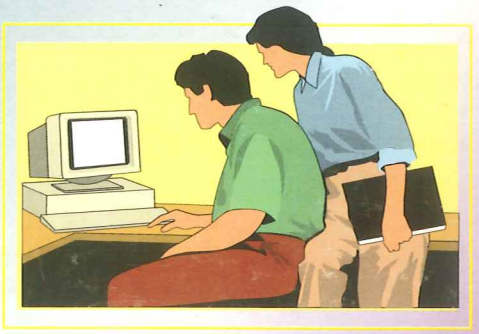
Review

Number 23 September 1994 Nicosia Cyprus

THE HIGHER TECHNICAL INSTITUTE





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

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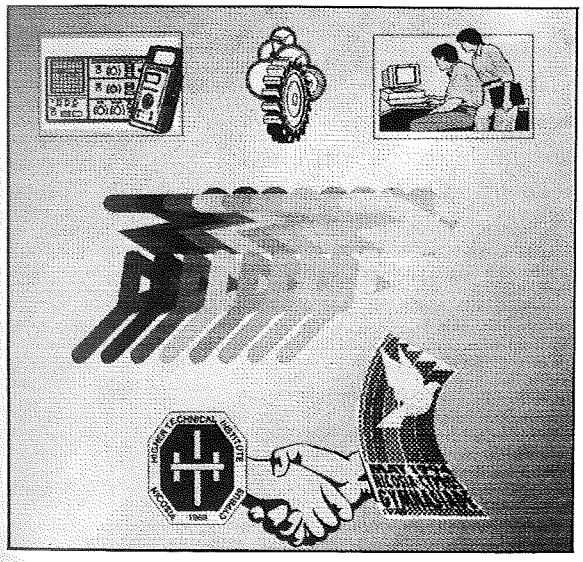

HTI designed and developed the computerised information system of the 10th ISF Games held in Cyprus. *Cover design* by Mr Chr. Makarounas and Dr M. Ioannides.

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1994 HTI Graduation Ceremony

This year's Graduation Ceremony of the Higher Technical Institute, held on Friday, 1 July, at the Cyprus International Conference Centre in Nicosia coincided with the culmination of the various activities organised to mark the 25th anniversary of the foundation of HTI.

The President of the Republic, Mr Glafcos Clerides, who honoured the Ceremony with his presence, awarded the Presidential Prize to Mr Nicolaos Damianou, the student with the highest overall performance.

In his address the President of the Republic inter-alia underlined the fact that HTI was a very successful bi-communal educational establishment where both the student population and the teaching personnel of both communities had been co-operating harmoniously by right up to the Turkish invasion in 1974.

The President promised that the Government would continue to support HTI in order to enable it to continue successfully its praise-worthy work.

Regarding the problems concerning the professional status of HTI graduates the President expressed the hope that these can be resolved with the appropriate co-operation of all interested parties and the active role of the Minister of Labour and Social Insurance whose interest in HTI is unrelenting.

It is generally acknowledged, the President added, that HTI has fullfilled its objectives to the utmost; its three thousand graduates have undoubtedly left their indelible mark on the Cyprus industry.

The President next congratulated the protagonists who helped found HTI and all those who contributed over the years to its success and ended his speech by wishing this year's graduates success in their future career and personal happiness.

The Minister of Labour and Social Insurance, Mr Andreas Moushouttas, awarded the diplomas to the one hundred and ninety-four graduates while the HTI Director, Mr Demetrios Lazarides, awarded the prizes sponsored by the local industry and other professional bodies to the students who excelled during the academic year 1993/94.

The Graduation Ceremony was also attended by the ex-President of the Republic, Mr Spyros Kyprianou, the Director General of the Ministry of L. & S.I., Mr. George Anastasiades, members of Parliament, members of the diplomatic corps and other dignitaries. There were also repre-

H.E. the President of the Republic awarding the Presidential Prize to Mr Nicolaos Damianou

The HTI Director delivering the Graduation Speech

sentatives of the political parties, the trade unions, professional organisations and the parents and relatives of the graduating students.

The gathering was also addressed by the President of the HTI Students Union, Mr Andreas Kyriakides, who highlighted the successful work of HTI in the twenty-five years of its existence. He called for professional recognition of the HTI graduates in the public, semi-government and private sectors.

The President of the Students Union added that HTI on the threshold of the year 2,000 needs a radical restructuring of its mode of operation and upgrading of its equipment in order to keep abreast with changes in the fields of engineering and technology.

The main speaker was the HTI Director who thanked the President of the Republic who honoured the Graduation Ceremony with his presence despite his extremely tight schedule. He also expressed his thanks to all those who over the years had contributed to the establishment of a really successful institution. "The proof of our success", the Director added "is the more than three thousand graduates who have been employed as senior personnel by many organisations and companies".

The Director underlined the fact that in addition to the one hundred and ninety-four graduates of the three year full time courses HTI had organised and run successfully during the current academic year forty-one (41) short courses which were attended by eight hundred and seventy-eight (878) in-service-professionals. Those professional courses had been organised with the close co-operation and financial support of the Industrial Training Authority of Cyprus and other professional bodies.

Mr Lazarides expressed the hope that HTI graduates would soon enjoy professional status and recognition - a step which would enhance HTI's role and enable it to continue to supply the market with high quality technician engineers.

Mr Lazarides drew attention to the fact that HTI personnel are involved in research projects which are financed by the Government, the European Union and the Med-Campus Programme.

The Director expressed his thanks to the HTI Board of Governors and the members of the various HTI committees who have helped HTI to run smoothly and efficiently. He also expressed his graditude to private industries, organisations and individuals who have offered generously donations, prizes and scholarhips.

The Director concluded his speech by wishing, on behalf of the Ministry of Labour and Social Insurance, all graduating students a successful career and happiness in their professional life.

Effect of Infill Walls on the Nonlinear Seismic Response of Steel Frames

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INTRODUCTION

Masonry and concrete walls are often used as partitions, especially in low and medium height structures. In many cases the walls are in the plane of frames; these infill walls may or may not be connected to the surrounding frame elements. Although they are sometimes intended and classified as structural elements, often they are considered as nonstructural partitions.

The consideration of the structural contribution of infill walls is important, especially for seismic lateral loading for which stiffness effects change the forces induced by earthquakes. Therefore, whenever they are present and connected to the frame, and especially if they are reinforced, it is advisable not only to consider them as load resisting elements but also to take advantage of their strength and stiffness. If their interaction with the frame is overlooked, the considerable damage (or loss of serviceability) they may suffer will not, also, be properly anticipated. More important, if infills are present they may also induce otherwise unanticipated damage mechanisms in the confining frames, e.g. yielding or plastic hinges at intermediate locations along beams or columns. Another aspect of the study of infill walls is the possibility to use them for strengthening existing buildings which have low earthquake resistance.

Importance of Infill Walls

Infill walls have attracted the attention of many researchers since the early 1950's, and much work has been undertaken to study their behaviour and interaction with the surrounding frames. In addition, efforts have been made to utilize infill walls as a means of producing economic designs by reducing the sizes of the members of the bounding frames.

From studies performed by various researchers, it is evident that infill walls can provide both an economic and practical means for the lateral stability of framed structures and a viable alternative for retrofitting existing structures to resist seismic, wind, and blast loads. Despite this, there is a reluctance from the engineering community to use this structural system widely and consider infill walls as structural elements. Commenting on this, Liauw and Lo [1] state that, «The reluctance of practicing engineers to consider the infills has been due, firstly, to lack of knowledge concerning the composite behaviour of infilled frames, and secondly, due to lack of practical methods for the stiffness and strength prediction».

Consequently, two schools of thought in seismic resistant design have been formulated concerning infill walls. In the first, it is required that the infills be effectively isolated structurally from the structural system, so that their structural effects can justifiably and correctly be neglected and in the second, infill walls are considered to be tightly placed and therefore, their interaction with the structural system to resist the effects of all kinds of excitations should be properly considered in the design, detailing and construction.

Commenting on the two procedures Bertero and Brokken [2] say that, «... the second philosophy offers more conceptual and practical advantages, particularly if the

basic structural system is moment resisting frame. This is because a main principle for seismic - resistant design is: Avoid unnecessary masses, and, if a mass is necessary, use it structurally to resist seismic effects. Thus, if walls and partitions are needed and the economical material is masonry or concrete, attempts should be made to use these infills as structural elements. The proper use of infilled elements can be of great practical value in strengthening and stiffening the usually very flexible moment resisting bare frame».

Therefore, although the subject of infilled frames has been studied for almost fourty years, there are still no definitive answers either about their behaviour and interaction with the bounding frame or about the estimation of their stiffness and strength. Some problems that make it difficult for practicing engineers to use infill walls as structural elements are the inherent nonlinearity, the high degree of variability, and the inherent degradability of infill walls. This reveals the difficulties associated with this problem and the need for more research to answer these long standing questions.

REVIEW OF THE BEHAVIOUR AND MODELLING OF INFILLED FRAMES

The behaviour of infill walls and their modes of failure are complex. A reason for this is that they consist of brittle inhomogeneous material and they have natural planes of weakness (e.g. mortar joints). The problem becomes even more complex when the interaction between the infill walls and the bounding frame is considered. Many parameters govern their behaviour which makes the experimental studies of this structural system very difficult and costly. Many researchers have studied the problem and tried to investigate the effects of as many parameters as possible. Most of them concentrated on the behaviour of the frames. Based on the experimental studies a considerable number of models have been proposed to model this complex and highly nonlinear behaviour.

In the first part of this section the behaviour and modes of failure of infilled frames is summarized while in the second part the most important parameters affecting the behaviour of infilled frames are presented.

Behaviour of Infilled Frames

The studies of the behaviour of infilled frames goes back to the 1950's. Most of the researchers studied the behaviour of infilled walls under monotonic or cyclic loading and only a few subjected model structures to dynamic loads. Although the response of a structure is different when subjected to cyclic loads as compared to dynamic loads, important information about the behaviour and modes of failure of infilled frames can be obtained from such experiments which allows the analytical modelling of this structural system. One of the essential pieces of information required in dynamic analysis is the load - displacement relationship on which an analytical model is based. This relationship can be obtained by testing infilled frames under monotonic loading.

The following modes of failure have been observed for non-integral infilled frames:

1. Diagonal cracking,
2. Sliding along a horizontal joint at the mid-height of the wall,
3. Combination of the above two modes, and
4. Diagonal crushing at the contact corners.

Every one of the above modes of failure of the infill walls result to a different mode of failure of the bounding frames as it is shown in Fig. 1. Although all the modes of failure are to be avoided because they result to column failures, the modes of failure (1) and (3) of the infill walls result to a ductile type of failure of the frame and therefore are tolerable while the modes of failure (2) and (4) result to a brittle type of

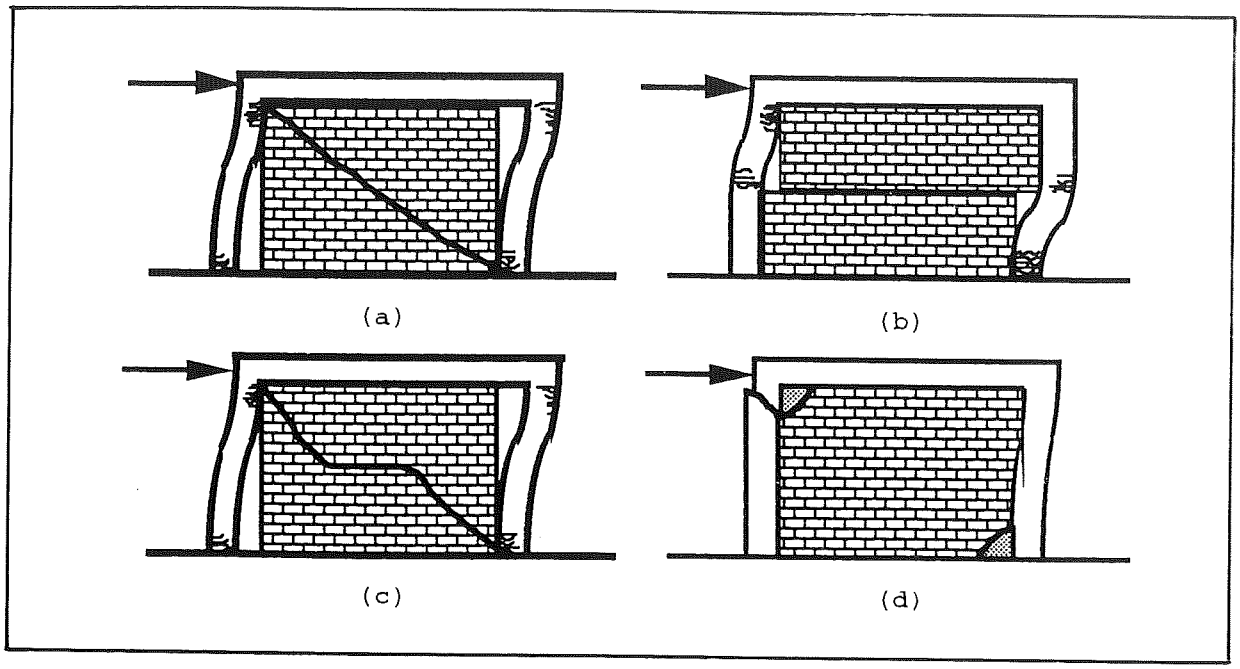


Fig. 1 Modes of failure of infilled frames

failure and should be avoided with the proper design of the infill wall and the frame. Th. Tassios and E. Vintzeleou [3] are proposing a criterion to avoid mode failure (2) and K. Stylianides and D. Sarigiannis [4] are proposing a criterion to avoid mode failure (4).

Parameters Affecting the Behaviour of Infilled Frames

The most important parameters affecting the behaviour of infilled frames are listed and discussed below. The effects of these parameters were investigated by various researchers either experimentally or analytically. Some of these parameters are specific to a particular type of infill material and may not apply to other types of materials but most of them are general and affect the behaviour of any type of infilled or bounding frame. The most important of these parameters are:

1. Length of contact,
2. Infilled modulus of elasticity,
3. Variation of masonry compressive strength,
4. Interface friction,
5. Effect of shear connectors,
6. Effect of openings,
7. Lack of fit,
8. Effect of the relative stiffness parameter (λh),
9. Influence of the height to length ratio,
10. Influence of beam stiffness.

These parameters affect, each to a different extend, the stiffness, strength and overall behaviour of infilled frames, as well as the force distribution in the members of the bounding frame. For example an opening on a wall (e.g. doors, windows etc.) which is located on one of the two diagonals of a wall causes about 70% reduction on the wall strength and about 60% reduction on its horizontal stiffness. Therefore, the above parameters should be taken into account to accurately model infilled frames.

This long list of parameters shows the complexity of the problem and the difficulties involved in the study of their behaviour both analytically and experimentally.

NONLINEAR SEISMIC RESPONSE OF INFILLED STEEL FRAMES

A Civil Engineer is most probably concerned with the effects that his decision, of whether to include or not infill walls in the analysis of a structure, will have on the overall design and actual behaviour of the structure. In this section it is attempted through examples to answer this question, or at least give some information which will facilitate this decision.

The steel structures selected for analysis are of low and medium height. The infill walls are modelled with six stiffness and strength degrading struts. Both material and geometric nonlinearities of the steel frame elements are modelled to obtain a realistic response of the structures.

In the first part of this section the infill wall model is described and in the second part three steel structures are analyzed; a one-storey one bay, a two-storey three-bay and a ten-storey three-bay. For each one of the structures two analyses are performed. In the first the stiffness contribution of the infills is ignored but the mass is included and in the second both their mass and stiffness contributions are modelled. The responses between the infilled and bare frames are compared to obtain an understanding of the effects of infill walls on the transient dynamic behaviour of steel frames subjected to strong earthquake motion.

Infill Wall Model

The model proposed for idealizing infill walls consists of six compression-only inclined struts as shown in Fig. 2. Three parallel struts are used in each direction and the off-diagonal ones are positioned at critical locations along the frame members. At any instance of the analysis only three of the six struts are active, shown in Fig. 2 with solid lines. The struts are switched to the opposite direction whenever they reach zero forces. The parameter α represents a fraction of the length or height of a panel and is associated with the position of the

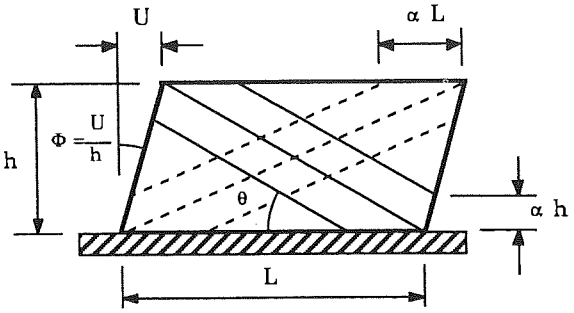


Fig 2 Six-strut idealization of infill walls

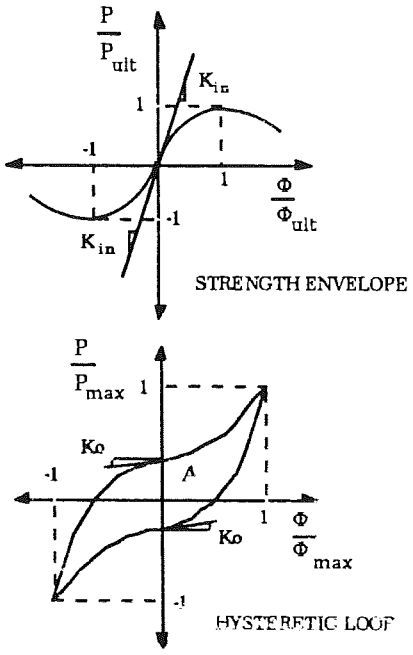


Fig. 3 Strength envelope and hysteretic loops

formation of a plastic hinge in a beam or a column. The magnitude of this parameter ranges between 0.25 and 0.33.

The hysteretic behaviour of the six struts is defined by two mathematical equations: the first defines the strength envelope, and the second the hysteretic loops of a wall. The shape of the strength envelope and the hysteretic loops, Fig. 3, depends on six parameters which can be obtained from experiments.

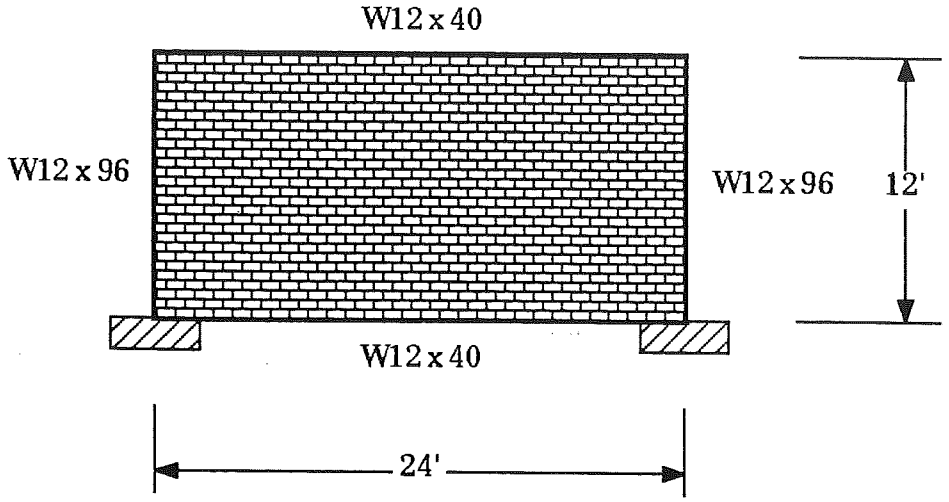


Fig. 4 Elevation of one-storey frame

Analysis Results

In this section the infill wall model is used to study the effects of infill walls on the nonlinear transient dynamic response of infilled steel frames. It is assumed that the steel frames were designed by ignoring the stiffness contribution of the infills but their mass was included. The change in the response of the frames when the infill stiffness and strength are accounted for is examined. Maximum accelerations and base shears, formation of hinges and their location, hysteretic behaviour of walls and force histories for selected steel members are recorded. A more detailed presentation of the results is given by Chrysostomou [5].

Response of a One-Storey One-Bay Planar Frame

In this section a comparison between the behaviour of the infilled and bare one-storey one-bay structure is presented (Fig. 4).

TABLE 1
Results of one-storey one-bay frame

	BARE	INFILLED
Elastic Period (sec)	0.466	0.279
Max. Recorded Period (sec)	1.017	0.421
No. of Pl. Hinge Locations	8	0
No. of Pl. Hinges Formed	36	0
Maximum Base Shear (kips)	182	-161
Max. Top Storey Acc. in/s^2	579	-439

The structure was analyzed twice: in the first analysis, the stiffness contribution of the infill was ignored but the mass was included (bare frame) and in the second both the mass and stiffness of the infills were modelled (infilled frame).

Table 1 shows a comparison between the response of the two structures. Two results are reported in the table concerning the plastic hinges. The first, which is the number of plastic hinge locations, is the number of frame member ends at which plastification occurred during the analysis, which can be used as a measure of the damage suffered by the frame. The second, which is the number of plastic hinges formed, indicated the number of loading / unloading cycles that these hinges have gone through, which can be used as a measure of the energy absorbed due to the hysteretic behaviour of the steel members.

The bending moment histories for the lower end of the left column and the left end of the roof beam are shown in Fig. 5 and Fig. 6, respectively.

Response of a Two-Storey Three-Bay Planar Frame

In this section the results of the analysis of the two-storey three bay frames are presented (Fig. 7). The structure was analyzed both with and without infill walls.

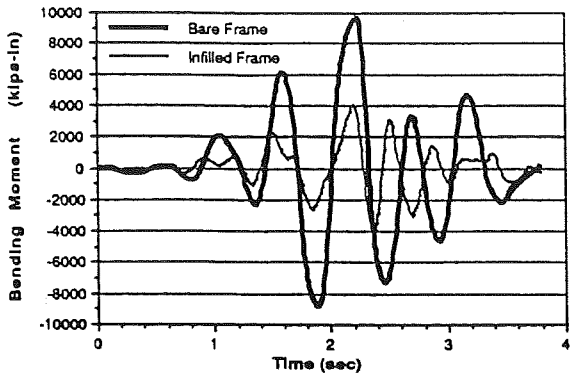


Fig. 5 Bending moment of left column of one-storey frame

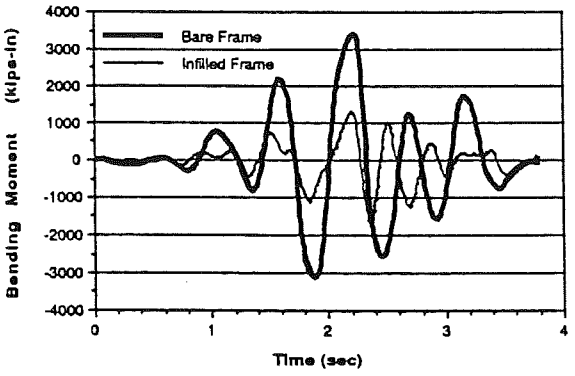


Fig. 6 Bending moment of roof beam of one-storey frame

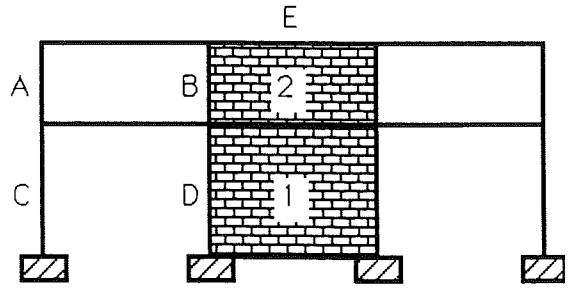


Fig. 7 Elevation of two-storey frame

Table 2 shows a comparison between the response of the two structures. The axial force time history for members B and C are shown in Fig. 8 and Fig. 9, respectively.

TABLE 2
Results for two-storey three-bay frame

	BARE	INFILLED
Elastic Period (sec)	0.867	0.375
Max. Recorded Period (sec)	1.538	0.823
No. of Pl. Hinge Locations	20	14
No. of Pl. Hinges Formed	150	59
Maximum Base Shear (kips)	-318	365
Max. Top Storey Acc. in/s^2	-344	346

Response of a Ten-Storey Three-Bay Planar Frame

In this section the results of the analysis of the ten-storey three-bay frame are presented (Fig. 10). As for the other two structures, two analyses are performed; one for the bare frame and one for the infilled frame.

Table 3 gives a summary of some of the results while Fig. 11 and Fig. 12 show the shear force time history for members C and E, respectively.

Conclusions from the Analysis of the Example Structures

In this section the results presented above are summarized and conclusions are drawn about the effects of infill walls on the non-linear transient dynamic behaviour of steel frames subjected to earthquake loading. Although the results are limited and only one earthquake motion was used for the analysis of the structures, general trends have been observed in the behaviour of the structures which are outlined below. The effects of the height and the number of bays of the structures are also examined. In the discussion below the one-storey one-bay, two-storey two bay and ten-storey ten-

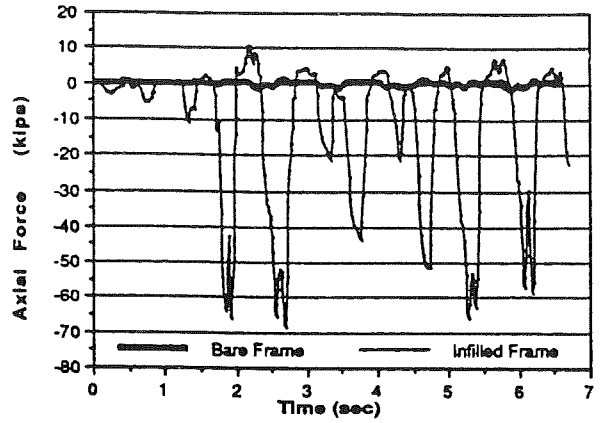


Fig. 8 Axial force in member B of two-storey frame

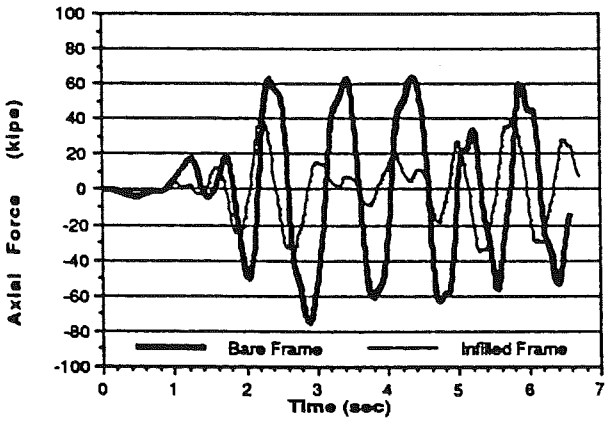
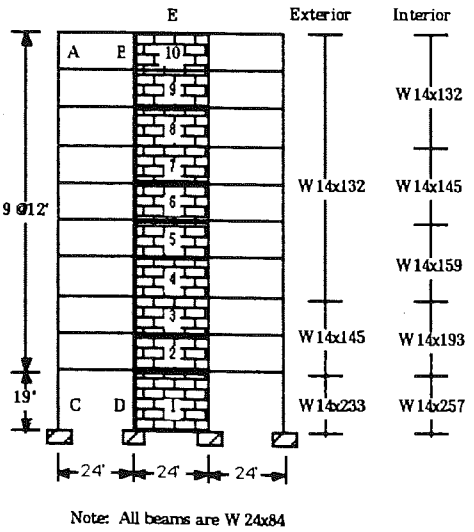


Fig. 9 Axial force in member C of two-storey frame



Note: All beams are W 24x84

Fig. 10 Elevation, dimensions and sections of the ten-storey frame

bay strustures are referred to as Frame 1, Frame 2 and Frame 3, respectively.

In comparing the maximum top storey accelerations and base shears recorded for the three frames (Tables 1, 2 and 3), it is observed that for Frames 1 and 3 the responses of the bare frame are larger than those of the infilled frame while for Frame 2 the opposite is true. For Frame 1 this can be explained by the fact that the periods of both the bare and infilled structures are to the left of the peak response of the El Centro response spectrum; therefore, a stiffer structure is subjected to smaller accelerations than a more flexible one which in turn results to smaller base shears. This is not the case for Frame 3.

For these structures, bare and infilled, one expects that the accelerations, hence the base shears, will be higher for the stiffer structure than for the flexible one, since the

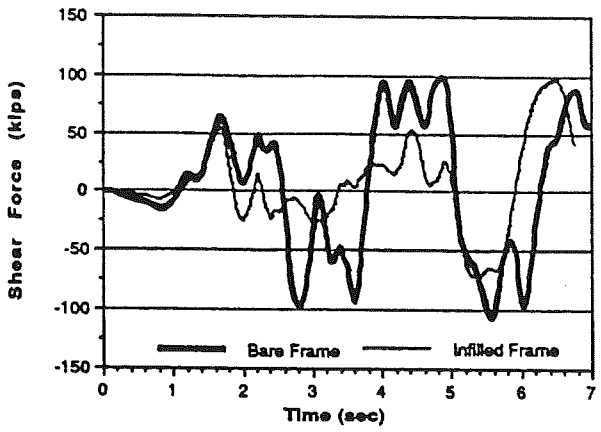


Fig. 11 Shear force in member C of ten-storey frame

elastic period of both structures are to the right of the spectrum peak. An explanation for this case is that the top storey acceleration for a multi-storey building is not representative of the overall response of the structure and therefore, it cannot be used to draw conclusions about the behaviour of the structures. This point is supported by the fact that the maximum base shear and maximum top storey acceleration for Frame 3 do not occur simultaneously which

means that the overall maximum acceleration occurs at a different time than the maximum top storey acceleration.

This difference can be attributed to the influence of modes of vibration other than the fundamental one, the contribution of which affects the response of the structures. As the height of the structure

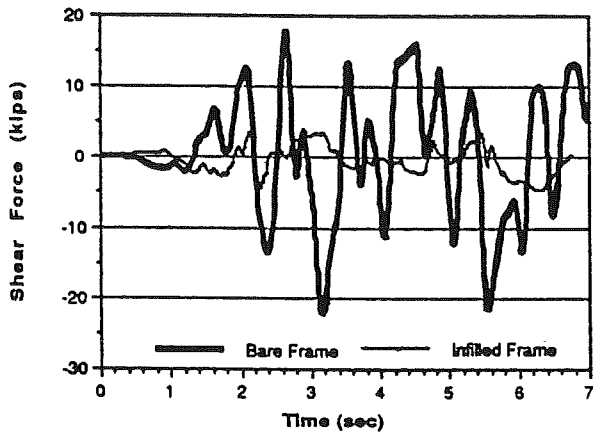


Fig. 12 Shear force in member E of ten-storey frame

decreases (less modes of vibration) this difference also decreases. For Frame 1, which has one translational mode of vibration, the maxima are recorded at exactly the same time while for Frame 2, although there is a difference, it is smaller than the one for Frame 3. Another explanation is that, since the infills undergo hysteretic loops which absorb energy, the accelerations which they experience are reduced. Therefore, even if they are stiffer, their energy absorption capacity reduces accelerations to which they are subjected and consequently, the base shears.

The infill walls have a significant effect on the axial forces of the frames. This is observed for all three of the structures analyzed. The members of the frames can be classified into two groups based on their response: the first group consists of members adjacent to infill walls, and the second of exterior members. The infill walls increase considerably the axial forces in the columns adjacent to the wall. In the top-storey columns these forces are predominantly tensile. Predominantly tensile forces are also observed in the columns of Frame 1 which can be considered as the top story of the other two structures.

This may have detrimental effects for reinforced concrete bounding frames while it may be beneficial for steel bounding frames. For the exterior columns the axial forces in the infilled frames are significantly smaller than the ones in the bare frame. The reason is that the infill walls concentrate a large part of the load to the adjacent columns and leave very little load to be carried by the exterior columns.

TABLE 3
Results for ten-storey ten bay frame

	BARE	INFILLED
Elastic Period (sec)	2.336	1.477
Max. Recorded Period (sec)	3.261	2.133
No. of Pl. Hinge Locations	90	31
No. of Pl. Hinges Formed	430	61
Maximum Base Shear (kips)	-535	530
Max. Top Storey Acc. in/s^2	350	-297

Exactly the opposite occurs for the bare frames in which the exterior columns carry most of the load produced by the overturning moment while the interior ones carry only a small amount. Therefore, the infill walls put a large demand for axial force resistance on the adjacent columns and this is a potential place at which failure may occur during a strong earthquake. This mechanism of resisting the overturning moment, which is enforced by the infilled frame, is considerably less efficient since the lever arm between the columns adjacent to the wall is much smaller than the one between the two exterior columns.

The effects of the infill walls on the bending moments and shear forces of the steel frames can be also classified in two groups

which are different from the ones for axial forces. In this case, the response of the members depends on the floor they are located instead of whether they are adjacent to a wall, or exterior. Therefore, the first group consists of members at the first floor of the structures and the second of members at the top floor. The members of Frame 1 can be classified in the top floor category. The time histories for members of the first floor follow the pattern of the base shear and acceleration time histories. This pattern is a function of the instantaneous tangent stiffness of the structure and the damage suffered by an infill wall.

It is observed that for most of the time history, the magnitudes of the forces in the infilled frame members are smaller than those in the bare frame, although there are some fluctuations, and after the infill wall at that floor suffers considerable strength and stiffness degradation, the response of the members in the infilled and bare frames becomes the same. On the other hand, for members at the top floor both the bending moments and shear forces in the infilled frame are considerably smaller than in the bare frame. Therefore, it can be concluded that the infill walls have a beneficial effect on the bending moments and shear forces of infilled structures, by causing significant reductions to their magnitudes.

It is observed from the hysteretic loops of the walls that the walls at the lower floors are damaged more extensively than the ones at the upper floors. The largest damage takes place at the first floor and then there is a gradual decrease in damage along the height of the structure with the wall at the last floor being the least damaged one. The location of the damaged walls dictates the part of the frame which will be subjected to plastic deformations. For Frames 2 and 3 hinges formed around walls which suffered considerable strength and stiffness deterioration while the rest of the frame members remained elastic. For Frame 1, since the wall did not exceed its ultimate capacity, no hinges formed in the bounding frame.

In general, infill walls reduced considerably the number of hinges formed in the bounding frame. While in the bare frames the hinges spread throughout most of the floor, in the infilled frames they formed only around damaged walls. Another difference between the response of the two structural systems is that the plastic hinges in the bare frames formed in both the beams and the columns of the frames while in the infilled frames they formed primarily in the exterior beams of the floors at which damaged walls existed, except in the lower floors where the walls were significantly damaged causing plastic hinges to the bounding beams and columns.

CONCLUSION

Based on the above results the following can be concluded:

1. The axial forces in the members of the bounding frame are significantly affected by the presence of infilled walls. Therefore, infill walls put a large demand for axial force resistance on the adjacent columns and this is a potential place at which failure may occur during a strong earthquake.
2. Infilled walls have a beneficial effect on the bending moments and shear forces of infilled structures, by causing significant reductions in their magnitudes.
3. Walls at the lower floors are damaged more extensively than the ones at the upper floors.
4. The location of the damaged walls dictates the part of the frame which is subjected to plastic deformations.
5. Infilled walls reduce considerably the number of members that undergo plastificaton. The number of loading and unloading cycles of these hinges is also considerably smaller for the infilled frames than for the bare frames.

From the above discussion it is evident that infill walls have beneficial effects on the behaviour of frames. The decision of whether to use them or not as structural

elements lies with every engineer who should decide based on the uncertainties concerning the modelling of infill walls and their location in a framed structure.

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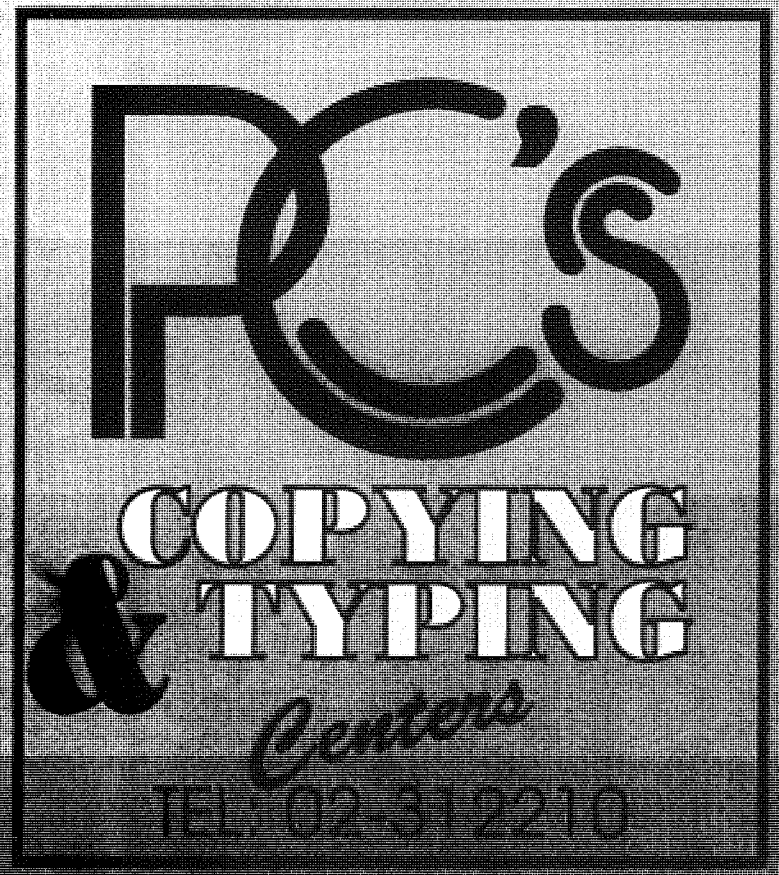

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An Investigation into the Performance of a Solar Assisted Heat Pump System

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ABSTRACT

This paper aims to analyze the operating features of a dual source solar assisted heat pump system and investigate its performance for a residential application in Cyprus, through computer simulation. For this purpose, a system model based on TRNSYS simulation programme has been used to correlate the performance of the system with the collector size and compare the performance of such a system with a purely solar heating system.

INTRODUCTION

A heat pump is by definition, a refrigeration system which has the ability to "pump" heat from a low temperature sink and elevate it to a higher temperature. The majority of existing heat pump systems utilise atmospheric (ambient) air as their heat source. Thus in a space heating application, the heat pump takes heat from low temperature outdoor air and transfers it to the room to be heated, at a higher temperature. Its performance is characterised by its coefficient of performance (COP) which is defined as the ratio of heat output over the work supplied to the compressor and is usually greater than unity.

One of the major characteristics of a heat pump is that its performance , or more particularly its COP, varies with the source temperature. In fact, the heat pump COP decreases as the heat source temperature drops. Thus, the COP of a typical air source heat pump reduces from 2.7 at an ambient air temperature of 15°C to about 2.1 when operating at 0°C (Reay and Macmichael, 1979). Bearing in mind that the heating load of a building increases with a decrease in the ambient air temperature, the above characteristic is a disadvantage for a heat pump system. On the other hand, the energy collected by a solar space heating system in winter is, very often, low in temperature to be useful for direct heating but it is high enough to be used by a water source heat pump. Such a combination will not only mean a better utilisation of the solar energy collected but will indirectly cause an improvement in the collector efficiency as a result of lower operating temperatures in the collector-storage subsystem. For the above reasons, the combination of a heat pump and a solar system may prove an efficient and probably a cost-effective method of space heating. The present study is a performance analysis and cost optimisation of a solar-assisted heat pump system for residential space heating.

SYSTEM DESCRIPTION

The solar assisted heat pump (SAHP) system under investigation is a combination of a base solar system and a heat pump system as illustrated in Fig. 1. The base solar system consists of a solar collector, a storage tank, a domestic hot water preheating system, a liquid-to-air heat exchanger coil in the building supply duct, auxiliary space and water heaters and all necessary controls.

The heat pump subsystem, which is exclusive for space heating, comprises a dual source heat pump which has two evaporators, one placed in a liquid stream taking hot water from the storage tank, and a second one which is placed outdoors to

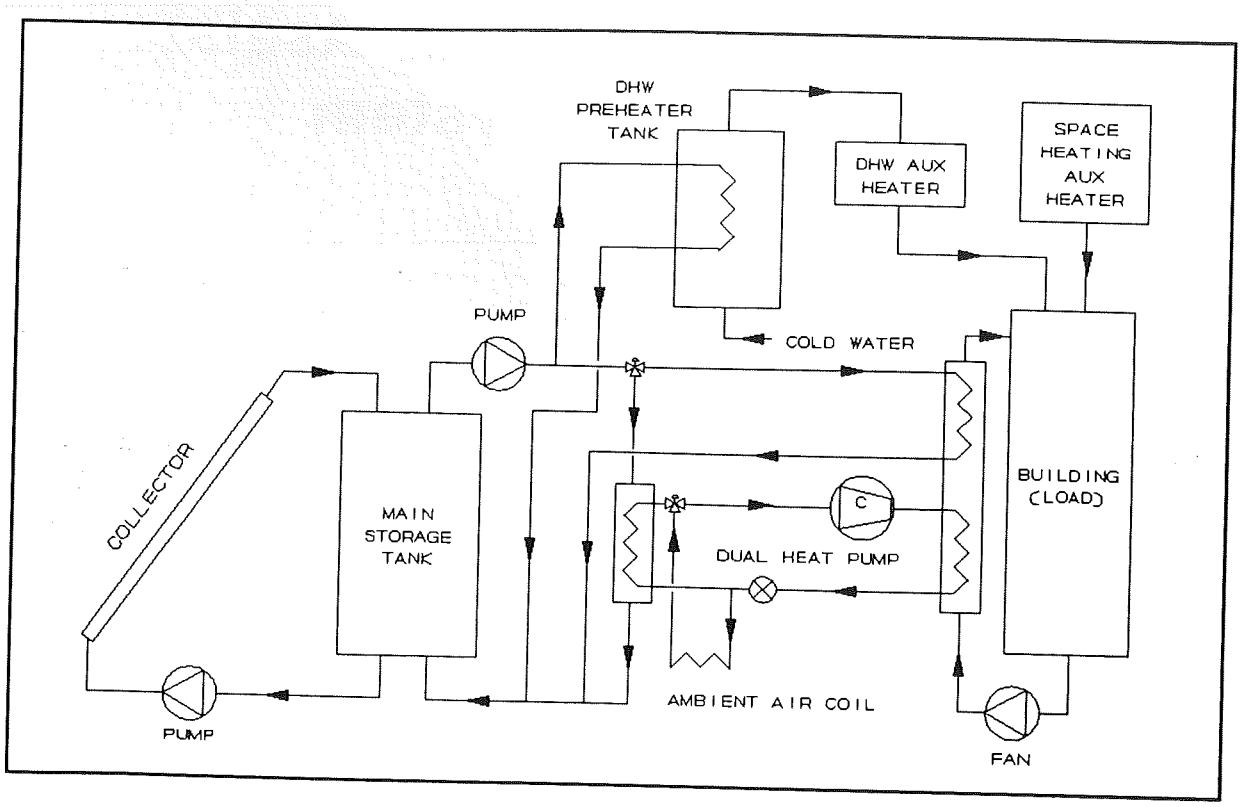

Fig. 1 Schematic diagram of a dual type solar assisted heat pump system

absorb heat from atmospheric air. This allows the heat pump to use either the hot water of the storage tank or the ambient air as the heat source, depending on which one results in a higher coefficient of performance (COP), i.e. the highest source temperature.

The service hot water subsystem consists of a preheat tank which incorporates a heat exchanger connected to the main storage tank, an auxiliary heater, and all necessary controls. The auxiliary heater makes up energy, when necessary, to elevate the temperature of service hot water leaving the preheat tank to 50°C.

Solar energy is absorbed by the solar collectors and stored into the main storage tank. Provided that there is sufficient energy in the storage tank, the pump will circulate the storage water to the load (service hot water and space heating).

THE SIMULATION MODEL

The complexity of the thermal analysis of solar-heat pump systems makes the use of computer simulations the only method capable of adequately determining the system dynamics. For this purpose the TRNSYS (Klein *et al,1990*) simulation programme was used to model and simulate the performance of the system.

The simulation model includes a number of TRNSYS component models, which include the collector and storage subsystem, the service hot water subsystem, the dual source heat pump and the weather generator which generates hourly weather data from monthly daily averages. For the

present investigation, the weather data used is that of Nicosia, taken from the Cyprus Meteorological Service (Meteorological Service 1975, 1985). The system model is described in more detail by Michaelides (1993).

The dual source heat pump model employed in the present study, models the performance of a heat pump having two evaporators; a liquid source evaporator to utilize heat from a solar system or other processes, and an ambient air source to be used when the outdoor temperature, T_a, exceeds the water source temperature, T_{so}, or if the liquid source temperature, T_{so}, approaches its freezing point. The model also allows a direct heating mode in which the hot water source bypasses the heat pump and delivers energy across a heat exchanger whenever its temperature exceeds a user specified minimum, $T_{sh,min}$.

The simulation model offers the flexibility to determine many energy quantities such as the incident solar energy on the collector, useful solar heat gained by the collector, space and water heating loads, auxiliary heat required, electrical energy required by the heat pump, energy delivered to the building by direct water source heating, energy absorbed by the heat pump evaporator, energy delivered by heat pump and the coefficient of performance of the heat pump (COP).

There are four possible operating modes of the system, as shown in Table 1, and the operating strategies are described below:

Mode A. If the storage water temperature (T_{so}) is smaller than T_{dh} and $T_{sh,min}$, and the ambient air temperature (T_a) is below $T_{a,min}$, then the heat pump is out of operation. In such a case, the auxiliary heaters

Table 1 Operating modes for a SAHP system employing a dual source heat pump

MODE	CONDITION	OPERATION
A	$T_{so} < T_{dh}$ $T_{so} < T_{sh,min}$ $T_a < T_{a,min}$	Heat pump OFF, auxiliary heaters ON
B	$T_{so} > T_{dh}$	Heat pump OFF, direct (solar) heating, collector–storage–load
C	$T_{so} < T_{dh}$ $T_{so} \geq T_{sh,min}$ $T_{so} \geq T_a$ $T_a < T_{a,min}$	Heat pump ON, water–to–air, collector–storage–heat pump
D	$T_{so} < T_{dh}$ $T_a \geq T_{a,min}$ $T_a > T_{so}$ $T_{so} < T_{sh,min}$	Heat pump ON, air–to–air

T_a = Ambient air temperature, °C
$T_{a,min}$ = Minimum ambient temperature necessary for ambient air source heat pump operation, °C
T_{dh} = Minimum water temperature necessary for direct heating (collector–storage–load), °C
T_{so} = Temperature of water leaving the storage tank, °C
$T_{sh,min}$ = Minimum water temperature necessary for heat pump operation using storage water source, °C

are activated in order to meet the space and DHW heating loads.

Mode B. If the storage water temperature (T_{so}) is equal or greater than the design flow temperature for heating (T_{dh}), then heat from the storage tank is transferred directly to the building through the load heat exchanger. The heat pump is again out of operation.

Mode C. If the storage water temperature (T_{so}) is lower than the design flow temperature (T_{dh}) but greater than the preset design minimum temperature ($T_{sh,min}$) and at the same time this temperature is greater or equal to the ambient air temperature (T_a), then the heat pump is activated to operate on the water-to-air mode, i.e it pumps heat from the warm water coming from the storage tank and transfers the elevated heat to the building.

Mode D. If the storage water temperature (T_{so}) is smaller than the design flow temperature (T_{dh}), and the ambient air temperature is equal or greater than the minimum design temperature for air source operation ($T_{a,min}$), and at the same time the ambient air temperature is greater than the storage temperature (T_{so}), then the heat pump operates on the air-to-air mode.

The simulation parameters used are listed in Table 2. The simulations assume that electricity is used as backup fuel, simply because the heat pump is electrically driven. However, the simulation model offers the flexibility to the user to assume a scenario which will use electricity for the heat pump and any other fuel for the auxiliary sources of heat. The need for such a scenario will depend on the economic performance of the system with electricity as energy source.

It is assumed that the daily hot water consumption pattern is similar to that of RAND (Mutch, 1974). The simulations assume that electricity is used as backup fuel, simply because the heat pump is electrically driven. However, the simulation model offers the flexibility to the user to assume a scenario which will use electricity for the heat pump and any other fuel for the auxiliary sources of heat.

Table 2
Simulation parameters for the SAHP system

1. Collector–storage subsystem	
A_c	10 – 200 m^2
G_{test}	54 kg h^{-1} m^{-2}
G	50 kg h^{-1} m^{-2}
$F_R(\tau\alpha)_n$	0.78
F_RU_L	24.4 kJ h^{-1} K^{-1} m^{-2}
β	50° from horizontal
V_s	0.5 – 10.0 m^3
U_s	1.2 kJ h^{-1} K^{-1} m^{-2}
2. Load (DHW+Space Heating)	
V_p	180 l
U_p	1.2 kJ h^{-1} K^{-1} m^{-2}
T_{req}	50 °C
M_D	160 l/day
UA	4000 kJ h^{-1} K^{-1}
T_R	20 °C
$\varepsilon_L C_{min}$	8000 kJ h^{-1} K^{-1}
3. Dual source heat pump	
T_{dh}	35 °C
$T_{sh,min}$	15 °C
$T_{a,min}$	5 °C

SYSTEM PERFORMANCE

The energy required to meet the space and water heating load (Q_{load}) comes from the following possible sources:

(a) Solar energy, either directly from storage to load or indirectly from the storage water through the heat pump operating at the water-to-air mode (Q_{sol})

(b) Energy absorbed from the ambient air by the heat pump (Q_{air})

(c) Electric energy required by the heat pump (Q_{ei})

(d) Auxiliary energy (Q_{aux}).

For a longterm simulation, the change in the amount of energy in the storage tank is negligible and the annual system energy balance is:

$$Q_{sol} + Q_{air} + Q_{ei} + Q_{aux} = Q_{load} \quad (1)$$

A useful index of system performance of these systems is the Solar-Air Fraction, **SAF**, which is the ratio of "non-purchased" energy (free energy from solar and ambient air) to the total heating load. This ratio is analogue to the solar fraction, f, used for conventional solar heating systems. The solar-air fraction is defined as:

$$SAF = \frac{Q_{sol} + Q_{air}}{Q_{load}} \quad (2)$$

The heat pump is driven by electricity while the auxiliary energy may be supplied by diesel oil, gas or electricity. Thus, SAF can also be expressed in terms of the energy required by the heat pump, Q_{ei}, and the auxiliary energy needed by the system, Q_{aux}, and is given by the formula:

$$SAF = \frac{Q_{aux} + Q_{ei}}{Q_{load}} \quad (3)$$

DISCUSSION OF SIMULATION RESULTS

A set of simulation runs for different collector areas were conducted in order to evaluate the performance of the system as a function of the collector size and the simulation results have been used to plot a number of graphs. Thus, in Fig. 2 the yearly collector efficiency and solar-air fraction were plotted as a function of collector area. The collector average efficiency is high at low collector sizes and decreases as the collector area increases. However, the solar-air fraction is low at small collector areas and increases as the collector area increases. The rate of increase in SAF is decreasing as the collector area increases. This is a result of the reduced collector efficiency associated with increased collector size.

The collector average efficiency and solar-air fraction were also plotted as a function of the collector to load factor, F_{cl}, which is defined as the ratio of collector surface area to the annual thermal load. It is expressed in m^2/GJ and can be used as a design criterion for a SAHP system. It can be seen from Fig. 3 that the new plots of collector efficiency and SAF versus F_{cl} follow the patterns of the curves of Fig. 2, i.e the collector efficiency decreases as F_{cl} increases and the solar-air fraction increases as F_{cl} increases.

It is interesting to observe the variation of the collector efficiency on a monthly basis. For this purpose the monthly average efficiency of collector has been plotted for three different collector sizes, 20, 60 and 120 m^2, as shown in Fig. 4. Superimposed to this graph is the variation of total load (service hot water and space heating). It is clearly demonstrated that the collector efficiency is lower at larger collector sizes. The collector efficiency is higher during the winter months when the load is maximum, and gets to a minimum during the summer months when the load is minimum (service hot water only). Another interesting piece of information is that the variation of the efficiency follows the pattern of the thermal load, i.e. high in winter and low in summer. It has been demonstrated by Fig. 2 that the solar-air fraction, i.e. the ratio of non-purchased (free) energy to the total load increases with the collector area. It is useful if a comparison is made with the solar fraction of a system that does not include a heat pump. For this purpose another set of simulations were run with modified parameters, so that the heat pump is put in operation only if the water temperature in the storage tank is higher than 100 °C, which is in fact impossible. This means that the system will operate as a conventional

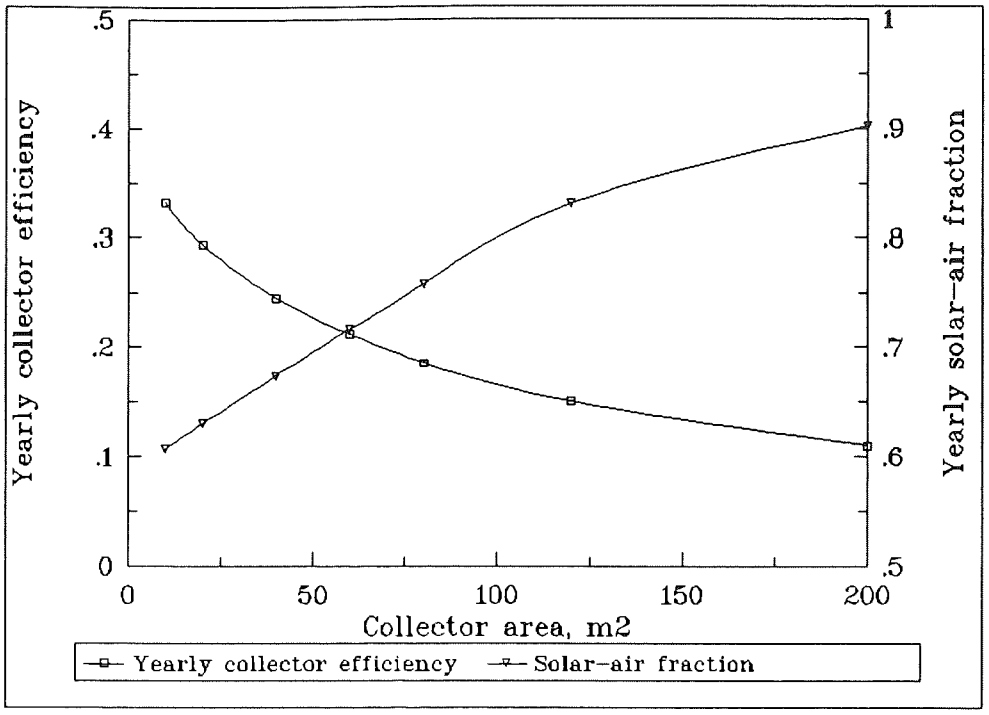

Fig. 2 Yearly collector efficiency and SAF as a function of collector size

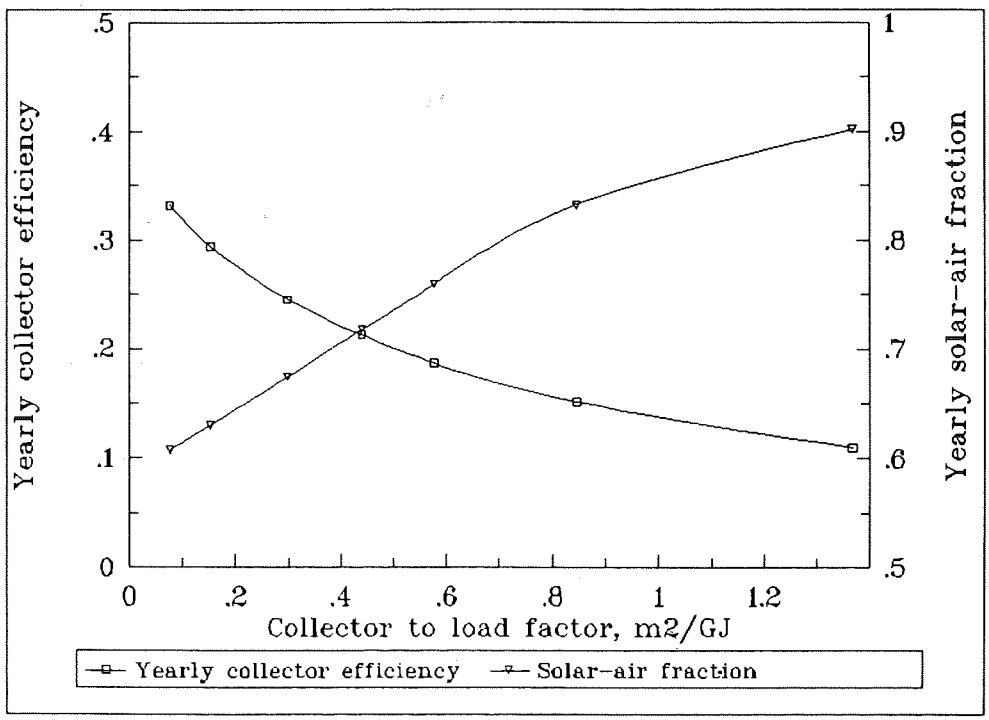

Fig. 3 Yearly collector efficiency and SAF as a function of F_{cl}

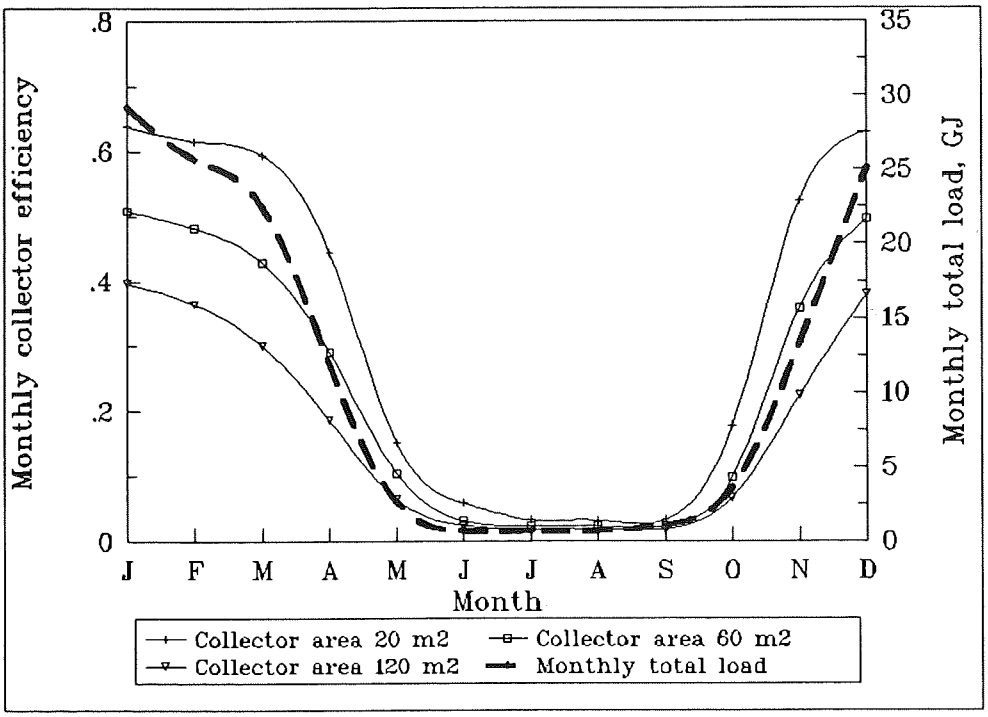

Fig. 4 Monthly collector efficiency at different collector sizes

solar water and space heating system without the intervention of the heat pump.

The results of these simulations have been used together with the results of the previous set of simulations to plot the graphs of Fig. 5 which show the fraction of the load met by a SAHP system and the fraction of the load met by a conventional solar heating system without the heat pump, as a function of the collector to load factor. Both fractions increase with the collector size. It is, however, interesting to note that at low F_{cl}, the solar-air fraction is much higher than the solar fraction of a conventional solar heating system and the difference represents the fraction of the load met by the heat extracted from the ambient air by the heat pump. This demonstrates clearly the importance of including the heat pump in the system. This difference, however, decreases as the collector size increases. This is explained by the fact that at large collector sizes, the building thermal load is, to a great extent, met by direct solar heating as a result of high amounts of energy collected by the solar system which, in turn, minimises the heat pump intervention.

The above is also demonstrated by the plots of Fig. 6 which illustrates the variation of the heat delivered to the building by the heat pump and by direct solar heating. It is very clearly shown that the heat delivered to the building by the heat pump as well as the heat absorbed by the evaporator and the energy input to compressor decrease as the collector size increases, while the energy delivered by direct solar heating increases with the collector size. As a result of the above, the contribution of the heat pump is reduced as the collector size is increased.

CONCLUSIONS

A solar assisted heat pump system for a residential application has been simulated using the TRNSYS simulation programme and the weather conditions of Cyprus. It

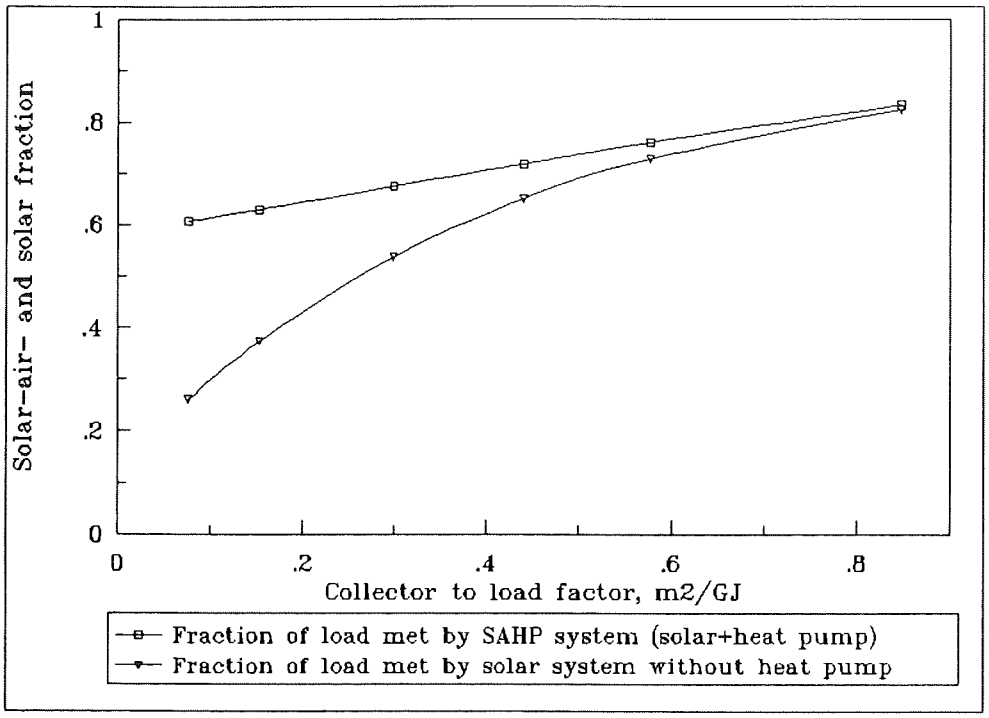

Fig. 5 Comparison of the fraction of load met by a SAHP system with the fraction met by a conventional solar heating system

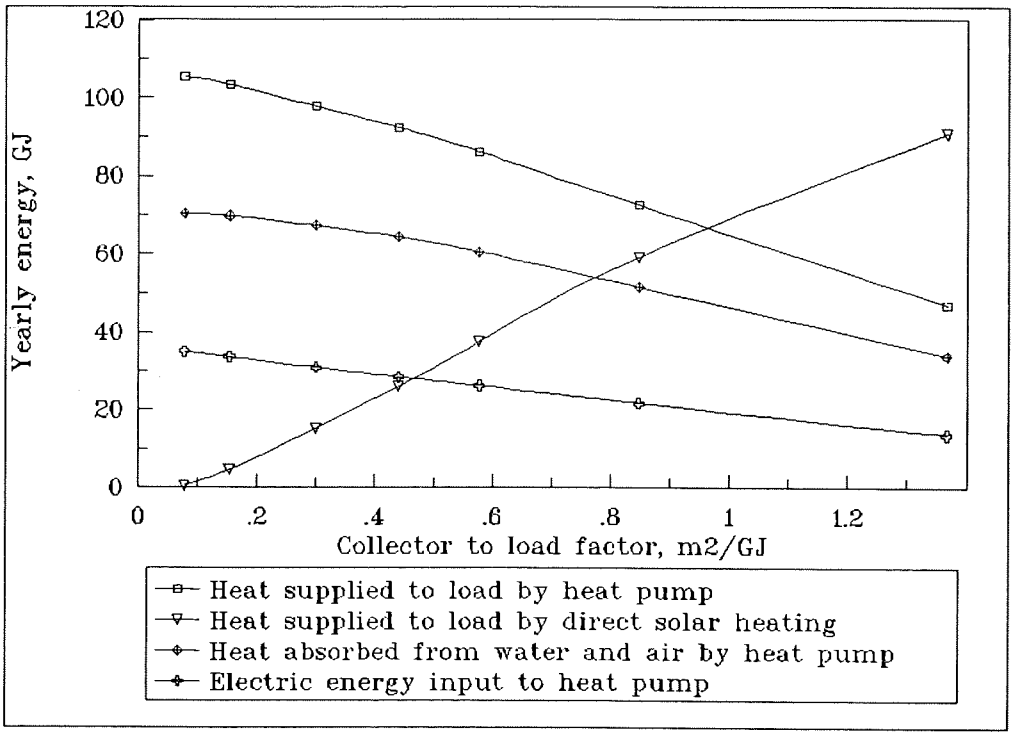

Fig. 6 Yearly energy quantities as a function of the collector to load factor, F_{cl}

has been demonstrated that in systems where a dual source heat pump is used in combination with a solar system there is a significant improvement in the thermal performance of the system, especially at small collector sizes, where the annual fraction of energy met by the SAHP system is increased by as high as 100% compared to a conventional purely solar heating system.

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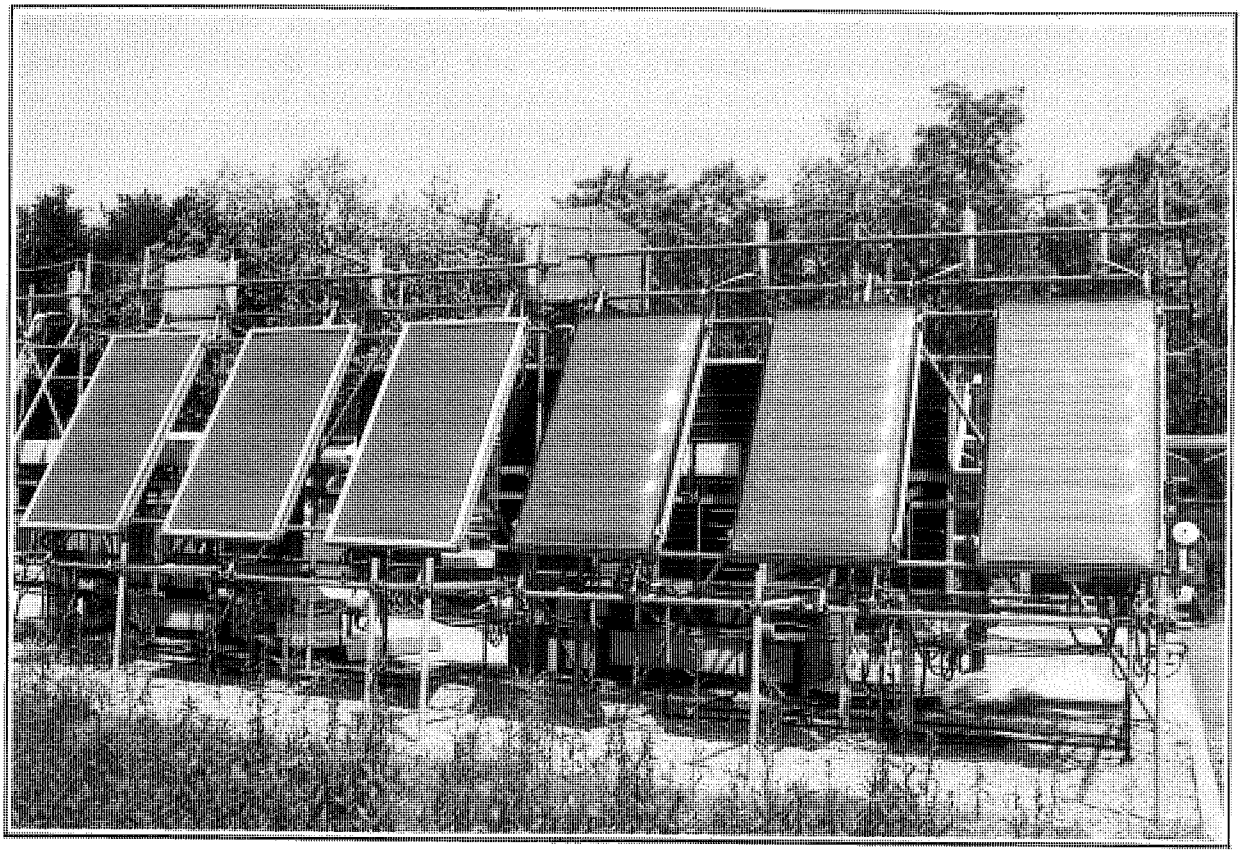
NOMENCLATURE

A_c	Collector area, m^2
C_{min}	Minimum capacitance rate in a heat exchanger, kJ h^{-1} K^{-1}
COP	Coefficient of performance
f	Solar fraction (fraction of the load that is met by solar)
F_{cl}	Collector to load factor, m^2 per annual GJ
F_R	Collector heat removal factor
F_RU_L	Slope of the collector efficiency curve, kJ h^{-1} K^{-1} m^{-2}
$F_R(\tau\alpha)_n$	Intercept of the collector efficiency curve
G	Collector mass flux, kg h^{-1} m^{-2}
G_{test}	Collector mass flux at test conditions, kg h^{-1} m^{-2}
M_D	Total daily mass demand of hot water, l
Q_{abs}	Energy absorbed from a cold source by a heat pump, kJ
Q_{air}	Energy absorbed from the ambient air by a heat pump, kJ
Q_{aux}	Auxiliary energy supplied to the system, kJ
Q_{dh}	Direct solar heat from storage to load, kJ
Q_{ei}	Electric energy required by the heat pump, kJ
Q_{hp}	Heat output by the heat pump, kJ
Q_{sol}	Solar energy, kJ
Q_{load}	Thermal load (hot water and space heating), kJ
SAF	Solar-air fraction



T_a	Ambient air temperature, °C
$T_{a,min}$	Minimum ambient temperature necessary for ambient air source heat pump operation, °C
T_{dh}	Minimum water temperature necessary for direct heating (collector-storage-load), °C
T_R	Room temperature, °C
T_{req}	Minimum required hot water delivery temperature, °C
T_{so}	Temperature of water from storage tank, °C
$T_{sh,min}$	Minimum water temperature necessary for heat pump operation using storage water source, °C
U_L	Collector heat loss coefficient, kJ h^{-1} K^{-1} m^{-2}
UA	Constant characterising the building, kJ h^{-1} K^{-1}
U_s	Heat loss coefficient of storage tank, kJ h^{-1} K^{-1} m^{-2}
V_p	Volume of hot water preheat tank, m^3
V_s	Storage tank volume, m^3
α	Absorptance
β	Collector tilt angle, degrees from horizontal
ε_L	Effectiveness of the space heating load heat exchanger
τ	Transmittance

ΚΑΡΤΑ ΥΓΕΙΑΣ ΖΑΚΟ - MEDNET*

* MEDNET: Διεθνής εταιρεία Διαχείρισης Προγραμμάτων Υγείας

Η ΖΑΚΟ ΑΣΦΑΛΙΣΤΙΚΗ με την πολυετή εμπειρία, πριν καταλήξει στην παρουσίαση ενός προγράμματος νοσηλείας ερεύνησε και συνδύασε όλες τις παραμέτρους της υφιστάμενης κατάστασης στο χώρο της υγείας και τις ανάγκες για ασφαλιστική κάλυψη του ανθρώπου του 2000. Το πρόγραμμα περιλαμβάνει μια σειρά από πρωτοποριακές παροχές όπως:

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- Επιλεκτική κάλυψη ανάμεσα σε 3 κατηγορίες
- Είναι ανεξάρτητη από ασφάλεια ζωής.
- Άμεση βοήθεια επειγόντων περιστατικών.
- Καλύπτονται όλα τα έξοδα τοκετού.
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- Χορηγείται χωρίς προηγούμενες ιατρικές εξετάσεις.

Αυτά τα χαρακτηριστικά, σε συνδυασμό με το λογικό κόστος του προγράμματος καθιστούν την κάρτα **ΖΑΚΟ - MEDNET** απαραίτητο και μοναδικό εφόδιο για το σύγχρονο άνθρωπο του 2000.

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Land Application of Treated Municipal Wastewater

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INTRODUCTION

The need to conserve and reuse water especially in arid and semi-arid regions where shortage of water is a serious problem, makes necessary that besides the conventional water sources water be evaluated for reuse, not only for protecting the environment, but also in replenishing ground aquifers and at the same time developing plant growth in arid zones.

Treated wastewater represents an unconventional water source which may be utilized for recreation, recharge of acquifers, agriculture and industry. Water can be purified to a certain extent depending on the final purpose of reuse.

In Cyprus there are no permanent surface water streams or lakes but until some years ago underground water resources were adequate to meet the local water demand. However, overexploitation of the underground water led to a gradual decrease of groundwater resources.

It is therefore necessary that reuse of sewage effluents be considered seriously as an important strategy in conserving water resources.

Moreover reuse of effluents in aquifer recharge, as well as for area development and agriculture with safety precautions may be a highly desirable alternative that will also reduce problems associated with other disposal methods.

It is anticipated that reuse of treated effluent as previously explained may affect physical, chemical and biological properties of soil and particularly soil salinity and sodicity.

As a result of the above, a research scheme is now executed at the H.T.I. in order to evaluate the environmental impacts of such reuse.

WATER QUALITY CRITERIA IN EFFLUENT REUSE

The physical properties and the chemical and biological constituents of wastewater are important parameters in the design and operation of collection, treatment and disposal facilities and in the engineering management of environmental quality.

The constituents of concern in wastewater treatment are: Total Solids, Dissolved Solids, Suspended Solids, Nitrogen (as N), Phosphorus (as P), Chlorides, Alkalinity (as $CaCo_3$), Grease and BOD_5.

Composition refers to the actual amounts of physical, chemical and biological constituents present in wastewater.

The composition of untreated wastewater and the subsequently treated effluents depend upon the composition of the municipal water supply, the number and type of commercial and industrial establishments and the nature of the residential community. Consequently, the composition of wastewater often varies widely among different communities.

Gross pollutional parameters "eg Biochemical Oxygen Demand (BOD_5), Suspended Solids (SS) and Chemical Oxygen Demand (COD)" are most routinely measured and reported as factors affecting wastewater quality.

In contrast the characteristics affecting agriculture or landscape irrigation are specific chemical elements and compounds that affect plant growth or soil permeability.

If landscape development is to be studied these chemical elements and compounds should be evaluated. These are in terms of Salinity the Total Dissolved Solids (TDS) and cations/ anions such as calcium, magnesium, sodium etc.

Nutrients are also important together with some other aspects as pH and Sodium Absorption Ratio (SAR).

The content in terms of the above dissolved minerals and nutrients will depend on the quality of the incoming domestic water supply, the nature of the waste added during use and the degree of treatment the wastewater receives.

It may then be concluded in general lines, that if the quality of domestic water supply is suitable for irrigation then the treated wastewater will also be suitable, although somehow degraded.

Careful consideration then must be given to the incoming water quality in order to be able to evaluate its long-term effects on soils.

SOIL CHARACTERISTICS

The physical, physicochemical and mechanical properties of the soil, such as dispersion of the colloidal phase, stability of aggregates, soil structure and permeability, are very sensitive to the type of exhangeable ions present in irrigation water. Thus, when effluent reuse is planned, several factors related to soil properties must be taken into consideration.

If reuse of wastewater will be applied for land development, or even for groundwater enrichment, no success can be expected unless the soil profile remains permeable, and this depends both on the proportion of exchangeable cations, other than Na, held by the soil and on the total concentrations of suitable salts in the percolating water.

Therefore besides the direct effect on the plants, Na in land application of water may affect soil structure and reduce the rate at which water can move into the soil as well as soil aeration capacity. The increase in soil sodicity, that occurs with most wastewaters due to high Na concentration even though leaching is allowed reduces soil permeability for water, particularly at the soil surface. Values for SAR and Electric Conductivity (EC) should then be used in combination, to evaluate the potential problem. Since reclaimed wastewaters are relatively high in sodium, the resulting high SAR should be a major concern in the project.

In terms of organic matter, the soil is a highly efficient biological treatment system. Organic matter is filtered by grass, litter, and top soil and is reduced by biological oxidation. Because high organic loading may create anaerobic conditions in the soil matrix and result in the production of odors, an intermittent loading schedule can be used which will allow air to penetrate the soil and supply oxygen to the bacteria that oxidize the organic matter.

As previously mentioned, exhangeable cations, particularly sodium, calcium and magnesium ions, deserve special consideration, as high sodium concentration in clay-bearing soils disperse soil particles and decrease soil permeability.

To determine the sodium hazard, the SAR developed by the U.S. Dept. of Agriculture is defined as follows:

$$SAR = \frac{Na}{\sqrt{(Ca+Mg)/2}}$$

where

Na = sodilum, meq/L

Ca = calcium, meq/L

Mg = magnesium, meq/L

High SAR values are considered values greater than 9.

LAND TREATMENT METHODS

Three principal processes of land treatment of wastewater are (i) irrigation, (ii) rapid infiltration and (iii) overland flow. Other processes which are widely used and generally less adaptable to large-scale use, include wetland application, subsurface application and agriculture.

In irrigation the applied effluent is treated by physical, chemical and biological means as it seeps into the soil. Where water for irrigation is valuable, crops can be irrigated at consumption use rates of 2.5 to 7.5 cm/week, depending certainly on te crop and other economic factors. On the other hand if water for irrigation is of little value, hydraulic loadings can be maximized up to 10 cm/week. Crops that can usually grow under this maximum rate are water tolerant grasses with lower economic return but higher nutrient - uptake capacities.

In rapid-infiltration systems, the effluent application rate could range between 10-210 cm/wk. Treatment occurs as water passes through the soil matrix and can include (i) groundwater recharge (ii) natural treatment followed by pumped withdrawals or recovery and (iii) natural treatment with renovated water moving vertically and laterally in the soil and recharging a surface watercourse.

Overland flow is essentially a biological treatment process in which wastewater is applied over the upper reaches of sloped terraces and allowed to flow across the vegetated surface to runoff collection ditches. Renovation is accomplished by physical, chemical and biological means as the wastewater flows in a thin sheet down the relative impervious slope. Overland flow can be used as a treatment process where discharge of a nitrified effluent low in BOD is acceptable, or as an advanced wastewater treatment process which is of main interest to this project. Rates of application of 15-40 cm/week are allowed for the latter purpose, depending on the degree of treatment required. Where surface discharge is prohibited, runoff can be recycled or applied to the land in irrigation or rapid infiltration systems.

LYSIMETRY AS A RESEARCH METHOD

The term "lysimeter" was derived from the Greek works "lysis" and "metron" meaning dissolved and measuring, respectively.

The term is thus applied to any device utilised for studying the rate, amount and composition of percolating water through a porous medium. Lysimeters are thus large containers, located in the field to represent the field environment with bare or vegetated surfaces for determining hydrological or environmental factors such as evapotranspiration or water balance.

The evapotranspiration (ET) is the summation of the irrigation water (I) plus the precipitation (P) minus the water percolating through the soil (D) and drained at the bottom.

$$\text{ie} \quad ET = P + I - D$$

The above is certainly considered as complete if the water content of soil remains constant. The different types of lysimeters offer various technical solutions for the determination and measurement of the different terms in the water balance equation.

CONCLUSIONS AND RESEARCH TARGETS

The principal objectives for land application of wastewater, besides the treatment of wastewater, are (i) economic return from use of water and nutrients to produce marketable crops, (ii) water conservation and (iii) preservation and enlargement of greenbelts and open space.

Treated effluent is generally used to achieve the latter two objectives, which will initially be considered as the research objectives. Water conservation is an objective that can be achieved mainly in arid areas. Parks, golf courses or landscape areas irrigated with potable water can be irrigated with treated effluent. The potable water previously used for irrigation can be conserved

or used for other purposes. When irrigation objective is the preservation and enlargement of greenbelt and open space, the site is usually chosen on the basis of land-use planning considerations.

Emphasis however will be given on the effect of applied effluent which will be of quality resulting from secondary treatment, on the permeability of the soil as well as the effect of the soil on the organic loading (BOD - COD) of the treated effluents, a quantity which is expected to end-up in the groundwater aquifers, provided that the soil will offer this facility.

For organic matter the soil is a highly efficient biological treatment system. Organic matter is filtered by grass, litter, and top soil, and is reduced by biological oxidation. Because high organic loading may create anaerobic conditions in the soil matrix and result in the production of odors, the possibility of treatment loadings will be investigated in order, that air will be allowed to penetrate the samples under investigation and supply with oxygen the bacteria that will oxidize the organic matter. Nitrogen removal, however, can be achieved through denitrification which in rapid filtration occurs when relatively long flooding cycles of BOD rich wastewater are added to create anaerobic conditions in the soil profile.

As factors of main concern in this research will be the quality of soil that will result after 2-3 years of irrigation with treated wastewater as well as the amount of organics removed by the soil, it will be important that soil of relatively high permeability be used which will not defeate the purpose of this objective. Rapid infiltration will be a method to consider which requires well permeable soil. As previously mentioned ranges around 10 cm/week may cover a combination of irrigation of some grasses together with advantages of rapid infiltration which include ground water recharge with the natural treatment and recovery of the initial effluent.

As the topic of land application of wastewater is a complex one, in order to reach to meaningful conclusions it will be necessary to keep certain parameters constant. The constant parameters are suggested to be the type of soil, the volume of soil, the hydraulic loading rates, and the quality of treated wastewater applied.

Evapotranspiration data is also considered as useful as it will determine the real amount of effluent that percolated into the soil for the purpose of evaluating infiltration rates. For comparison purposes evapotranspiration process is suggested to be carried with clean potable water at a nearby lysimeter that will contain the same amount and quality of soil, as the ones under investigation.

Four lysimeters which will simulate the actual environmental conditions each containing one cubic meter of the soil sample will be used for this research. The use of the lysimeter has been found to be the most appropriate not only for water balance control and permeability determinations but also for various other reasons previously mentioned, including soil quality evaluation. Soil columns may also be used if such need arises.

The targets set here cover a wide range of factors that should be investigated. It will be expected however that as the research proceeds, the focus will be directed on more specific items, narrowing down the initial proposals and probably slightly diverting from them.

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The Development of a Portable Impact Spot Welding Gun

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This article outlines the results of current research work carried out at the Higher Technical Institute on the development and testing of a portable impact spot welding gun.

INTRODUCTION

Impact spot welding is an extension of explosive welding, where, similar or dissimilar metals could bond as a result of high velocity oblique impact. It was well known during the First World War that a bullet or shrapnel could adhere to the metal surfaces they impacted [1]. The occurrence of this scientific phenomenon was not appreciated as a welding process at that time and it was only in 1944 that Carl [2] recognised it as a solid phase welding process. This chance observation was then developed during the next 50 years to what has today become a well established industrial process. Furthermore this revolutionary technique was adapted to produce small diameter spot welds for electrical connections and many other applications where solid phase spot welds between dissimilar metals are required.

DEVELOPMENT OF A SPOT WELDING GUN

A small "HILTI" type nail gun was modified to generate high speed water jets. These modifications include nozzles, cartridge chamber with water reservoir and firing head assembly. These components were designed and manufactured at the HTI. Details of the spot welding gun and the modified parts are shown in Fig. 1 (a) and (b)

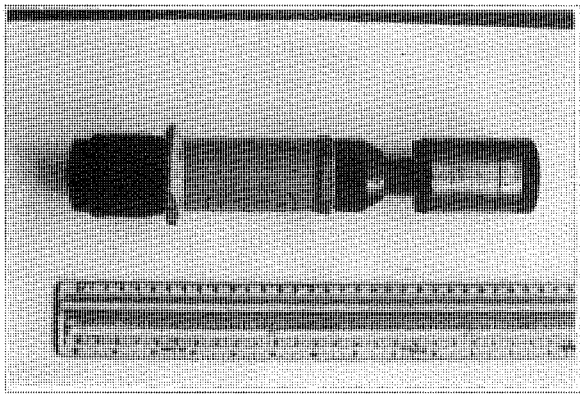


Fig. 1(a) Photograph of the assembled spot welding gun

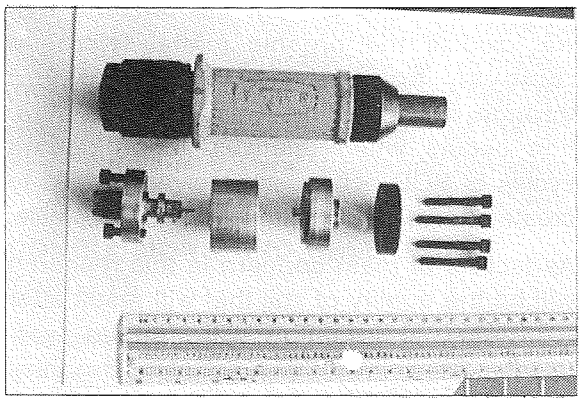


Fig. 1(b) Components of the spot welding gun

PRINCIPLE OF OPERATION

When the cartridge is fired, is forcing the water next to it, through the nozzle at a very high speed (250 m/s). As soon as the jet comes out of the nozzle and starts travelling through still air, its tip begins to mushroom forming a hemispherical front. High speed photographs of explosively generated waterjets are shown in Fig. 2.

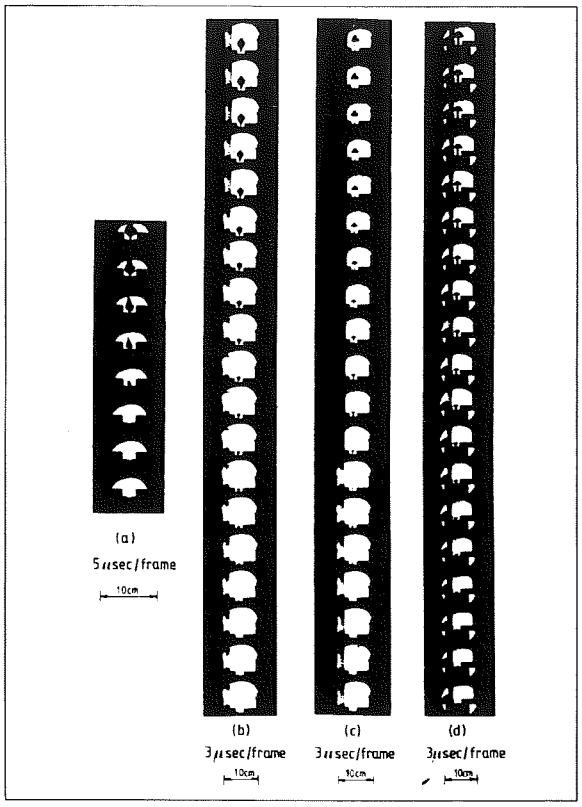


Fig. 2 High speed photographs of water jets

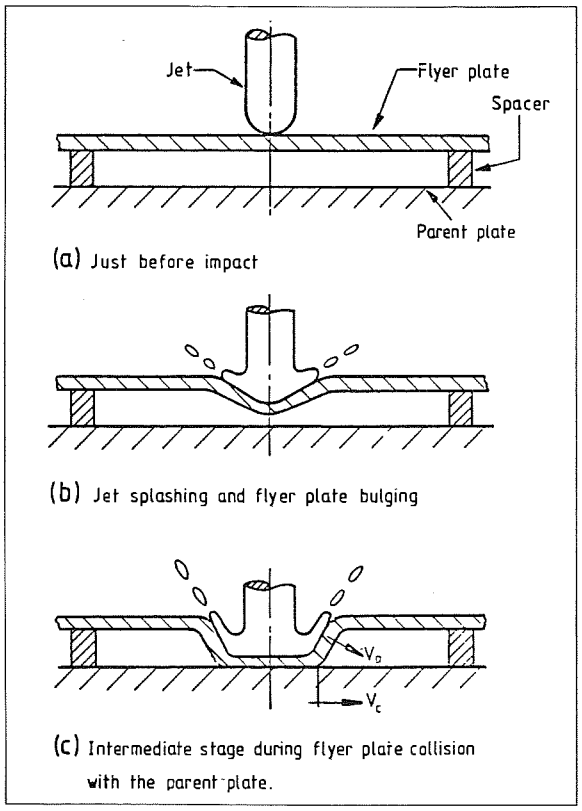


Fig. 3 The spot welding mechanism

These jets have been used to accelerate a thin metal sheet (flyer plate), against a rigid base plate (parent plate) as shown in Fig. 3.

The flyer plate travels through a small air gap, 1 to 2mm, and impinges on the parent plate obliquely. The angle of obliquity between the flyer and parent plates is very important as it determines the extent of plastic deformation that takes place between the plates and whether the plates will weld or not.

A great number of tests were carried out by firing water jets through various diameter nozzles on plasticine and lead targets to ensure that the jets were not atomising and that they did not break during their travel through air. For the production of spot welds a 4 mm diameter nozzle was used together with high strength cartridges.

RESULTS

Various tests were carried out in an attempt to produce spot welds between copper and steel and brass and steel with some very promising results. The first tests were on copper flyer plates and steel parent plates with successful spot welds (see Fig. 4). However, due to the low strength of copper the flyer plate was torn apart by the explosive shock and rapidly expanding gases.

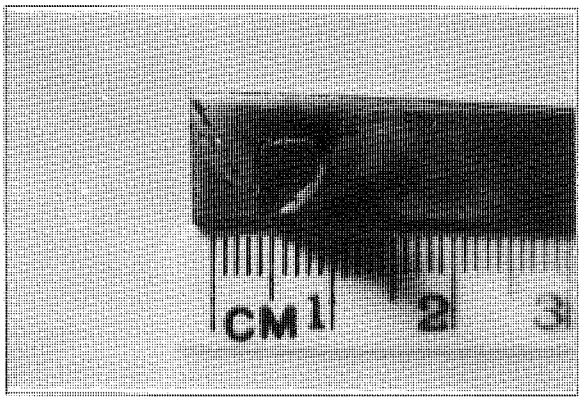


Fig. 4 Photograph of a copper/steel spot weld

Due to limitations on the explosive, loading of cartridges it was decided to use various metal combinations to avoid damage of the test pieces.

Tests were also carried out on brass flyer plates and steel parent plates with very encouraging results (Fig. 5). The size of the spot weld is less than 5 mm in diameter with very good surface finish.

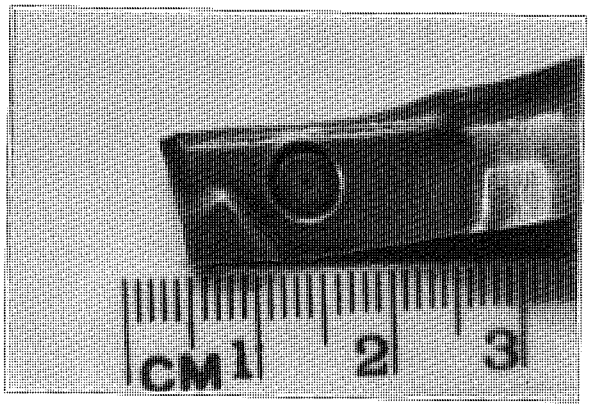


Fig. 5 Photograph of a brass/steel spot weld

The strength of the weld was examined by subjecting the brass plate to a peel test (bending the plate upwards and putting it under tension). See Fig. 6 for details.

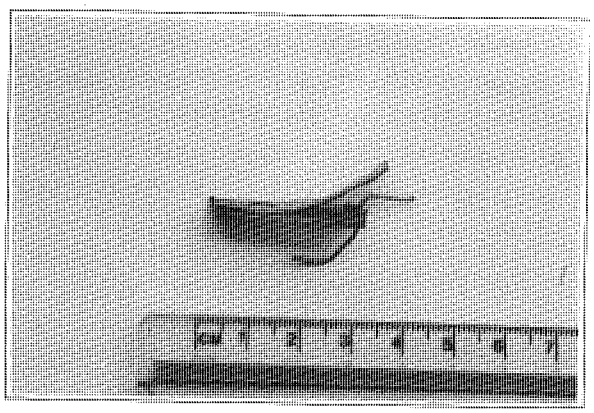


Fig. 6 Peel test on a brass/steel spot weld

It was found that the strength of the weld is higher than the strength of the brass plate itself. Further tests were carried out with two flyer plates of copper foil and an aluminium base plate. In this case a spot weld was produced by joining the three plates as a multilaminate composite in a single shot. These specimens were cut, ground, polished and etched for metallographic examination.

METALLURGICAL OBSERVATIONS

The interface of the welds was examined under the microscope, a typical view of a three layer spot weld shown in Fig. 7. At the interfaces, there appears the characteristic deformation of the metal plates at the colliding faces. This deformation resembles a waveform which is a result of the oblique collision of the plates. From Fig. 1(b) it can be seen that the flyer plate impinges on the parent plate at an angle. As soon as the plates come into contact the spot weld expands radially outwards to approximately the diameter of the mushrooming jet. This is like an expanding ripple when a stone is dropped in a pond.

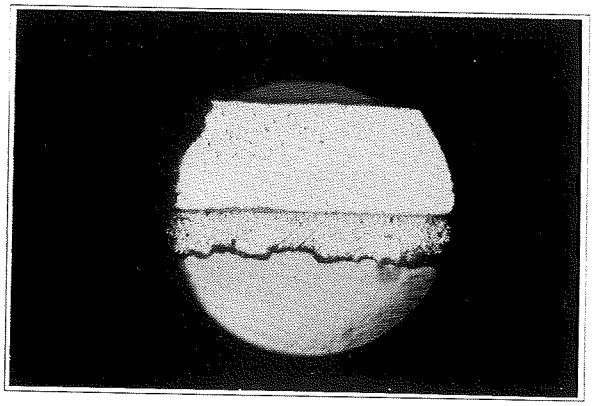
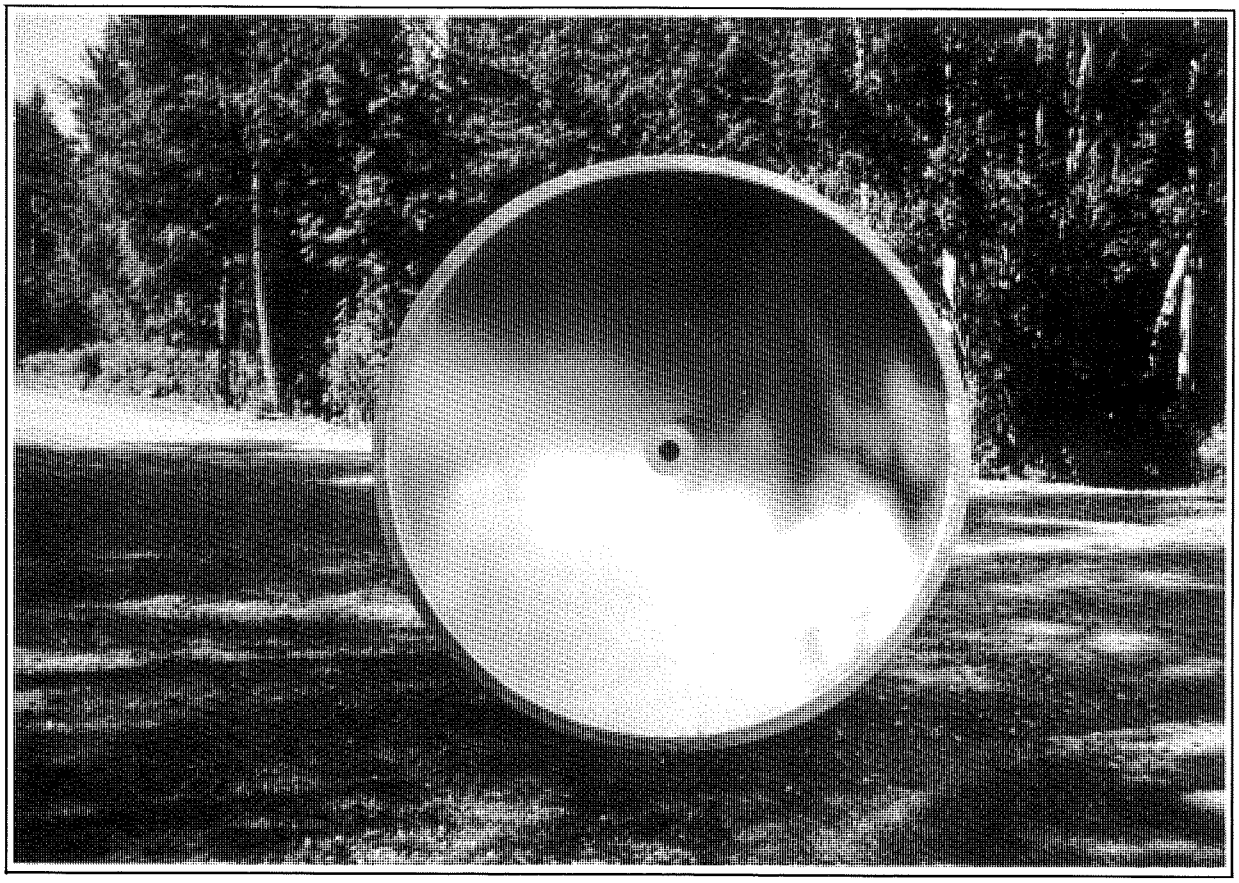


Fig. 7 Photograph of an aluminium/copper/steel spot weld

In the case of metals the plates collide obliquely at a very high speed generating pressures at the interface which are several times greater than the yield strength of either of the two metals. Under such pressures metals behave like fluids. Due to the presence of a flactuating pressure gradient ahead and behind the collision point conditions of turbulence are induced at the interface causing the wave-like bond between the metals which is a characteristic of all explosive welds [3].



Satellite dishes of any size may be produced by explosive forming

FURTHER WORK

Further work is required to determine the following:

1. Effect of the size of the interface waves (deformation) on the mechanical strength of the welds.
2. Minimum size of a spot weld that can be produced.
3. Use of other types of jets or projectiles to produce spot welds.
4. Practical commercial applications of the impact spot welding process.

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Women Civil Engineers and Technicians in Cyprus

THEIR PARTICIPATION, POSITION AND BEHAVIOUR AT WORK

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ABSTRACT

During the last two decades there has been a considerable increase in the number of women who followed Civil Engineering careers in Cyprus. In 1993 women Civil Engineers constituted 18.2 % of the total number of men and women Civil Engineers registered by the Council of Registration of Architects and Civil Engineers. There was also a considerable increase in the number of women HND diplomates in Civil Engineering. The objective of this paper is to investigate the factors which influenced Cypriot women to pursue a career in Civil Engineering. Furthermore to demonstrate and account for the apparent differences in the position, remuneration and the employment conditions of women Civil Engineers and Technicians in comparison to that of men Civil Engineers and Technicians.

INTRODUCTION

During the last 30 years there has been a considerable increase in the participation of Cypriot women in the labour force. In 1992, women constituted 38.7 per cent of the total economically active population. The transformation of the structure of the economy after independence, and the effects of the Turkish invasion in 1974, resulted in employment opportunities for women in a variety of sectors, other than in agriculture.

Despite their increasing numbers Cypriot women are concentrated in female dominated occupations such as Clerical, Services and Sales, while their participation in Managerial and Professional occupations is very low. There is a distinct occupational segregation of the sexes which is among the most marked in Southern European countries.

However, the changes in the socio-economic structure of the island, especially after the Turkish invasion resulted in a gradual increase in the participation of women in occupations other than their 'gender expectation' such as Accountants, Economists, Engineers and Lawyers.

The reactivation of the economy after 1976, offered to men and women employment opportunities in the developing sectors of construction, manufacturing industry and tourism. Furthermore, the use of modern technology in industry and the other sectors of the developing economy led to a considerable increase in the number of men and women following third level education locally and abroad.

The rapid growth in the construction industry, especially during the early post invasion years, in 1976, increased the demand for Civil Engineers. Women Civil Engineers entered the Civil Engineering profession in 1960, but their number increased significantly in subsequent years.

Between 1970 and 1993 the number of women Civil Engineers registered by the Council of Registration of Architects and Civil Engineers increased from 5 to 321; women constituted 18.2% of the total number of men and women registered.

There was also a considerable increase in the number of women HND diplomates in Civil Engineering. Most of the HND diplomates are graduates of the Higher Technical Institute (HTI), the only state in-

stitution offering courses in Engineering in Cyprus.

Between 1971 and 1993 the number of women who graduated from the HTI in Civil Engineering increased from 3 to 371; they constituted 40.4% of the total number of men and women who graduated in Civil Engineering from HTI.

The objective of this work is to investigate the factors which influenced Cypriot men and women to pursue a career in Civil Engineering. Furthermore to demonstrate and account for the apparent differences in the earnings, position and behaviour at work of women Civil Engineers and Technicians in comparison to that of men. The research study concentrates primarily on Greek Cypriot women, since the Turkish invasion in 1974 has kept the Turkish minority inaccessible.

With this objective in mind a sample survey was carried out and questionnaires were issued to men and women Civil Engineers and Technicians and their Employers. The sample group consisted of 100 men and women Civil Engineers and Technicians, HTI graduates, (25 from each group) and 25 Employers, who were Civil Engineers and Civil Engineering Technicians.

CHOICE OF SPECIALISATION

Statistical information indicates that during the 1980s Engineering Technology ranked first in the preferences of Cypriot students studying abroad. More than 50% of women enrolled in Engineering Technology in Cyprus and abroad were enrolled in Civil Engineering specialisation while the corresponding proportion of men was about 30%.

The survey indicated the following reasons for the choice of Civil Engineering as a profession :

a) The employment opportunities offered by the developing construction industry. This was the major factor which influenced men and women to choose Civil Engineering as a profession.

b) The education opportunities offered by HTI. HTI offers high quality education free. HTI graduates are normally offered good employment terms with prospects, while many prospective Civil Engineers consider the HTI as the first step towards higher education. In addition, many parents prefer their children, particularly females to study in Cyprus in their own environment and within their relative control and protection.

c) Male's exposure to the construction industry either through employment or through graduating from Technical schools. During the last 15 years about 25% of male secondary education students were enrolled in the Technical and Vocational stream compared to less than 6% of females.

d) The fact that in Cyprus there is no clear distinction between the role of the Architect and the Civil Engineer has influenced many women to follow Civil Engineering.

e) Civil Engineering is considered more compatible to a woman's nature than the Mechanical and Electrical Engineering professions. Civil Engineering in most cases requires less outdoor work than the other two specialisations.

EARNINGS AND POSITION OF WOMEN CIVIL ENGINEERS

The development of the construction industry offered to Civil Engineers posts of high calibre and their status was raised in the public opinion. Civil Engineers and Architects belong to the occupational group of professionals and rank second in the ladder of highly paid employees after Legislators, Senior Officials and Managers with Technicians and Associate Professionals in the third place.

The earnings of Civil Engineers and Technicians in the Private sector are lower than in the Public sector. Women's earnings are lower than males in both sectors.

According to The Annual Wages and Salaries Survey (1992), the ratio of female to male gross monthly salary of Architects and Civil Engineers was 90% in the Public sector and 78% in the Private sector. In the case of Technicians the corresponding ratio was 86% in the Public sector and 70% in the Private sector. It should be noted that in 1992 the average female to male gross monthly salary for both sectors for all occupational groups was 66%.

Figures 1 and 2 indicate that in the Private sector the ratio of female to male monthly earnings of Civil Engineers and Technicians is much lower than in the Public sector, while there is a marginal difference between the monthly salaries of female Civil Engineers and male Technicians.

The late entry of women in the Civil Engineering profession and the consequent reduced promotion opportunities is a basic factor for the differences in the earnings of men and women Civil Engineers, especially in the Public sector, where there has been equal remuneration for men and women since 1960. There are no women holding Managerial posts in any of the major Public and Private establishments of the Construction industry.

The majority of the men and women respondents believed that the social status and the position of men Civil Engineers is higher than women's. The following issues were raised by the sample group with respect to the lower monthly rates of pay of women:

a) Men Civil Engineers are appointed to better posts than women. Women Civil Engineers are normally employed in posts of secondary importance with less responsibilities, fewer promotion prospects and lower salary.

b) Men Civil Engineers are more appreciated and respected than women by the employers and by ordinary people. There are very few women Civil Engineers who are comparable to men.

c) Another reason mentioned by men was women's lack of site experience or reluctance for outdoor work.

d) Women supported that women Civil Engineers are not encouraged to work on site. Newly employed women are generally viewed with suspicion as to whether they will be able to fulfil their obligations as Engineers. Therefore they have to prove themselves in order to be accepted and respected as equal.

The following reasons were given by the employers for the lower remuneration of women :

a) Women are reluctant to take responsibilities.

b) Women are willing to work for lower salaries.

c) Women do not normally work above their contractual commitments.

d) Women are unable to cope with the demands of site work.

BEHAVIOUR AND GENERAL PERFORMANCE AT WORK

The aim of the survey was to establish the behaviour and performance of women Civil Engineers compared to that of men. To examine any incidence of discrimination and to examine issues as the performance of women at work, tasks undertaken, work on site, over-time, travelling to other towns etc. The survey indicated the following with respect to the above mentioned issues:

a) With the exception of Site Management, where women were under-represented, there were no major differences in the tasks undertaken by men and women Civil Engineers. However, there were striking differences in the tasks undertaken by men and women Technicians. Women Technicians were mainly involved with Quantity Surveying and Technical Drawing while their involvement with Site Supervision duties was negligible.

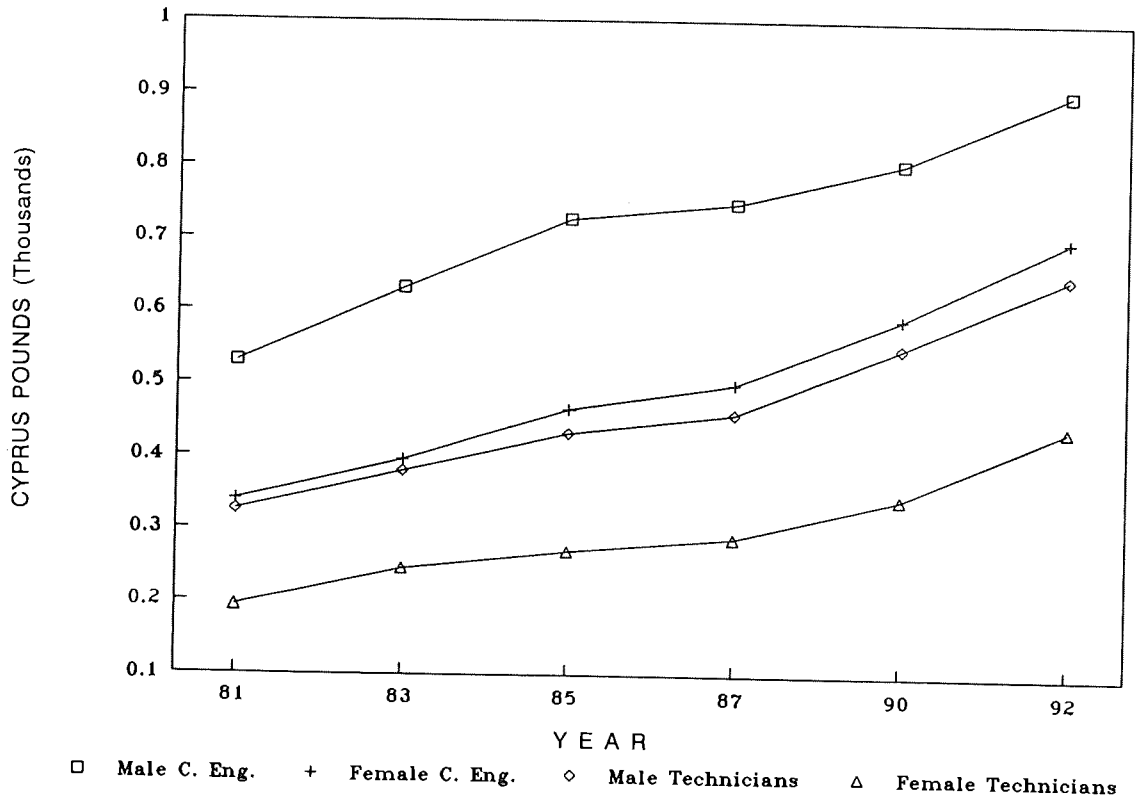

Fig. 1 Gross average monthly salary of Civil Engineers and Technicians in the Private sector

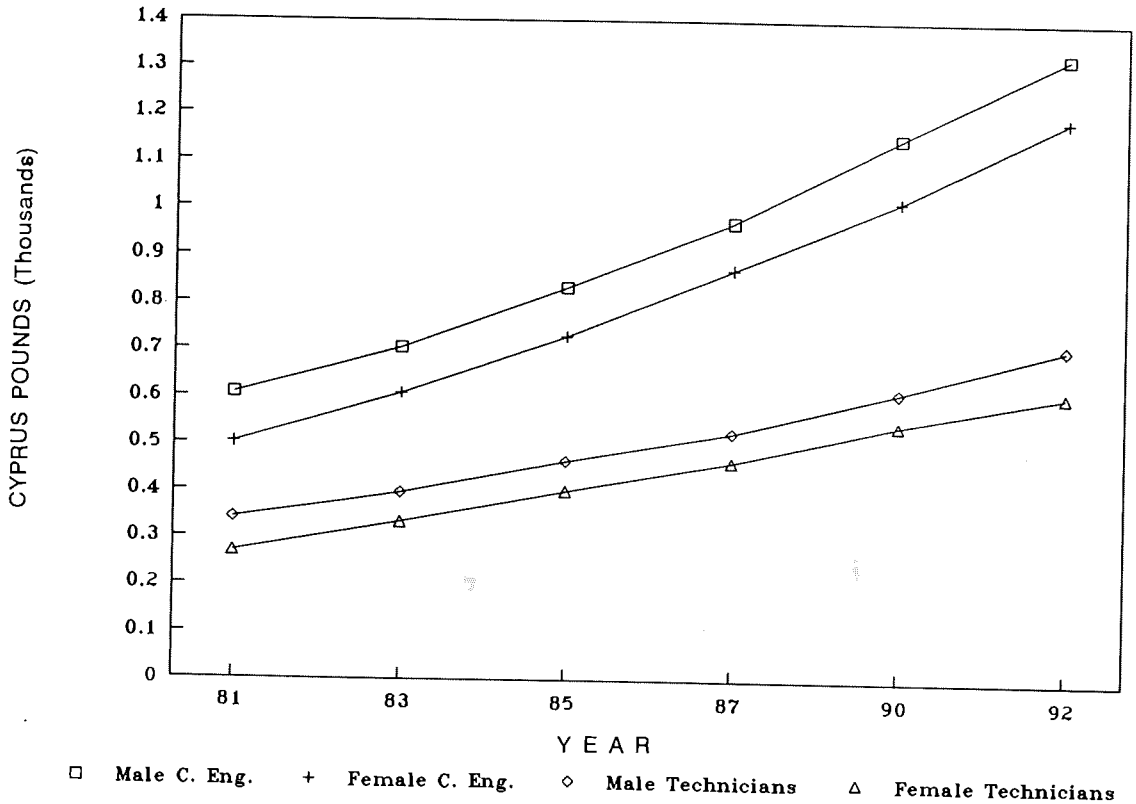

Fig. 2 Gross average monthly salary of Civil Engineers and Technicians in the Public sector

On the contrary, men Technicians were equally involved with Quantity Surveying, Site Management and Site Supervision duties.

b) Women Civil Engineers and Technicians in the sample group worked mostly in the office whilst men divided their time equally between Office and Site Management duties.

c) A higher percentage of men than women in the sample group worked over-time and travelled to other towns in the execution of their duties. It was also noted that the majority of men Civil Engineers worked unpaid overtime.

d) The majority of the employers responded that family responsibilities reduced the performance of married women with children. A small proportion took this view for married men with children.

e) About half of the women respondents supported that they had been discriminated against in their working experience. They mainly were discriminated against by an employer, by male and by female workers. They explained that they were discriminated by an employer with respect to work on site, assignment of responsibilities, promotions and salary.

f) The majority of the employers (66%) responded that had male and female candidates with the same qualifications applied for the same post, but in more than 40 per cent of the cases women candidates were not considered. The main reasons given by the employers were :

1) Men are more experienced for site work.
2) Men are willing to work extra hours.
3) Men are willing to travel to other towns.

g) All the respondents believed that family obligations hinder the professional evolution of women Civil Engineers and Technicians. Women are allotted with two jobs at the same time, since they are responsible for most family obligations as well as employment responsibilities.

Although a considerable number of males appeared to help with the raising of children and to a certain extent with housework, women were mainly responsible for these duties. Generally women took time off to attend to sick children or other personal family matters.

h) The respondents confirmed that gender role socialisation was primarily responsible for giving priority to women's family obligations before employment duties.

A woman Civil Engineer working at the same government Department as her husband stated

"Although we both go home the same time, I feel that it is not natural or ethical for my husband to help with domestic duties."

Men considered work as their first and ultimate priority and they were willing to work above their contractual agreements at the expense of their family and social life. A man Civil Engineer employed by a large Construction company stated:

" I need to work extra hours every day. I am so tired when I go home that I cannot even speak to my children and my wife. My work commitments leave me very little time for any social activity."

CONCLUSION

In Cyprus, historical and socio-economic changes brought about a rapid growth in the construction industry and increased the demand for Civil Engineers.

Women Engineers entered the Civil Engineering profession in 1960, but their number has increased significantly after 1980.

Male and female HTI students during their training in construction works

Employment prospects in the growing construction industry and education opportunities offered by HTI were the major reasons which influenced men and women to follow Civil Engineering.

Civil Engineering is considered as more compatible to a woman's nature than Electrical and Mechanical Engineering.

The social status, the professional achievements and position of men Civil Engineers are higher than women's. Men Civil Engineers are appointed to posts of primary importance and their earnings are higher than women's in the Private sector.

Women are considered inferior to men concerning site work. There are more differences in the duties and work behaviour of men and women Technicians than men and women Civil Engineers.

The results of the survey indicated that women's gender expectations and family obligations as well as employer's prejudices hinder women Civil Engineers to pursue professional equality with men Civil Engineers. There is a long way to go until women Civil Engineers can be favourably compared to men.

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The Cost of Quality

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INTRODUCTION

In this high competitive business world the elimination of waste (anything that does not add any value to the product or service) is perhaps one of the most important selling points of Total Quality. Waste reduction in concerned with identifying ways in which the cost of achieving quality can be reduced.

The cost of quality is the only effective measure of an organization's quality. Most conventional accounting systems do not analyse the total costs of quality. However, quality costs can be measured and are often used in reporting the quality performance of a company. The main drawback is that they provide a relative indication against a historical performance but do not provide an absolute measurement. The importance of quality cost is stressed by one of the quality gurus, Philip Crosby, in one of his four absolutes; Quality measurement: Price of Nonconformance [1].

The cost of achieving quality consists of tree elements: The cost of getting it right first time (delivering your product or services to customers conforming to their requirements). The cost of getting it wrong (where you actually fail to deliver right from the first or conform to product requirements or services) . Finally there is the cost of lost opportunity when not only you get wrong but that the customer tells somebody else what you got it wrong.

THE COST OF QUALITY

A more orthodox breakdown of the cost of quality is the following five categories [3]:

Prevention Appraisal	}	Positive contribution to conformance
Internal failure External failure	}	Non-conformance
Lost opportunity	—	Long-term loss

a) Prevention

BS 6143 defines prevention costs as: - "The cost of any actions taken to investigate, prevent or reduce defects and failures" [2]. Is that of designing things right in the first place, training people to do their jobs properly, organizing the business so that work is done efficiently and effectively and so that improvements can be made all the time.

b) Appraisal

Appraisal is concerned usually with those "after the event" activities that are associated with product inspection and test, measuring, quality control, monitoring of processes and so on.

c) Internal failure

Internal failure is the cost when you discover that something has gone wrong before you ship a product or deliver a service. Internal failures are not just waste, scrap, rework and so on, but they are associated with other countless elements which contribute to the failure to be put right. Internal failure may include poor design, poor research and development

work, poor manufacturing of engineering work etc.

d) External failure

External failure is where a product or service actually gets to the customer before discovering that something has gone wrong. Companies tend to cost this in terms of warranty, repairs, but there are several other costs associated with this as well. Consider the engineers' time and effort that are involved, not just in repairing, but in putting right the relationship with the customer, extra sales effort etc.

e) Lost opportunity

The cost of this lost opportunity is generally the highest of the cost of quality, where companies may even lose potential business that they did know existed. Unfortunately many companies may never get to hear about it. They probably could assess it but they will very rarely hear of specific cases. Many organizations have no idea how much business they are losing through poor quality eg telephone operators, bad treatment by someone in the company, companies' difficulties' behaviour etc. [3].

Recent surveys among those companies who measure quality costs raise the amount to 20-25% of annual turnover for manufacturing industries and to 35-45% for service industries.

From the above mentioned five quality costs prevention is the only one which actually adds value to the products or services. So prevention is the only quality costs that companies should tolerate. The cost of non-conformance, reported as being typical in many US and European businesses, amounts around to 20-30% of a company's annual expenditures [4]. In detail for the five elements of quality costs expressed in % of annual sales turnover rises to lost opportunities 10%, failure 10.5%, appraisal 7.5% prevention 3.0% [3].

Figure 1 is a graphical representation of the above components. Prevention and appraisal costs are costs of assuring quality while internal and external costs are the failure and scrap costs. The aggregate of these costs produce the total quality cost curves.

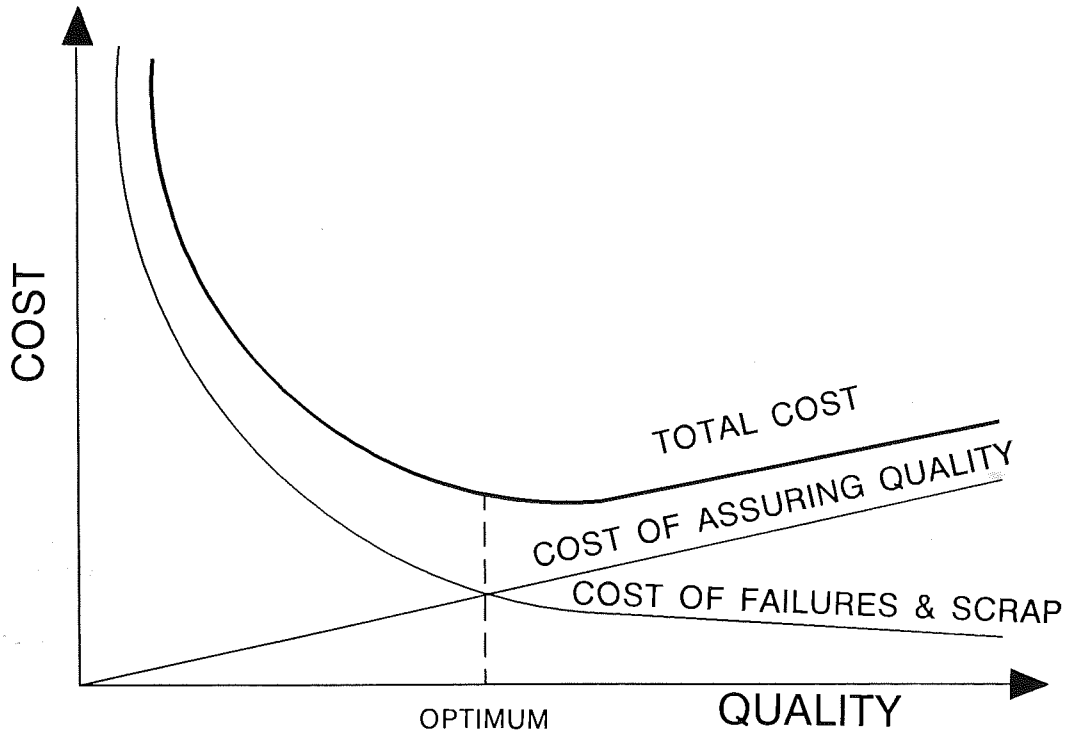


Fig. 1 Graphical representation of different categories of quality costs

Table 1 Possible quality cost categorizations into POCs and PONCs

PRICE OF NON-CONFORMANCE (PONC)		PRICE OF CONFORMANCE (POC)	
Reprocessing	I.F.	Review	A
Expediting	I.F.	Checking	A
Unplanned Service	I.F.	Audit	A
Computer returns	E.F.	Quality education	P
Inventory	I.F.	Testing	A
Customer complaints	E.F.	Process proving	A
Service after service	E.F.	Procedure verification	A
Downtime	I.F.	Prevention	P
Reconciliation	I.F.	Inspection	A
Warranty	E.F.	Quality planning	P
Rework	I.F.	Quality circle activity	A
Scrap	I.F.	Calibrations	P
Design changes	I.F.	Manuals	P
Repairs	I.F.	Work Inspections	A
Accidents	I.F.	Safety	P
Lost of sales	L.O.	Maintenance	A
		Systems - procedures	P

Note: Appraisal A, Prevention P, Internal Failure I.F., External Failure E.F., Lost Opportunity L.O.

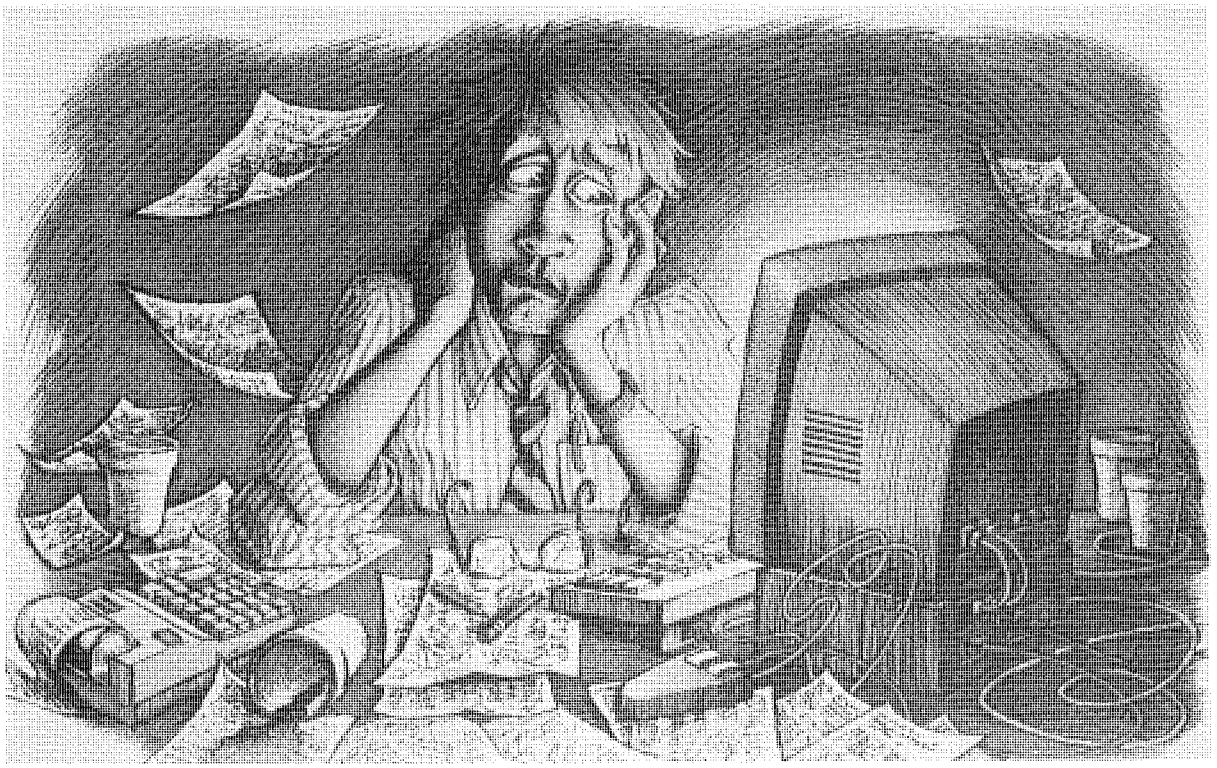
It is advisable that companies should constantly try to reduce appraisal costs, internal and external failures, lost opportunity and customly try to keep appropriate levels of prevention costs to make sure that value is added in their products and services into an optimal point.

AN ALTERNATIVE APPROACH - PONCs & POCs

Apart from the approach which has been elaborated above which is according to BS 6143: 1990, Philip Crosby though his definition of quality "Conformance to the requirements" rather than "meeting specifications", suggested an alternative approach. He speaks about a management tool which is the "price of non-conformance" [5].

If price is "conformance" then getting it wrong is a "non-conformance" - the cost being defined as the "price of non-conformance (PONC)". Thus in whatever a company does, if it is wrong a PONC arises and this can be measured in terms of rework and involvement of other people.

On the other hand, there is price of conformance (POC) - cost of any preventive ac-



tions which are aimed at stopping non-conformance occurring.

So the total cost of quality (COQ) can be seen as the sum of POCs and PONCs.

An example of Quality cost categorization into POCs and PONCs is given to Table 1 [5]. On the same table the letter opposite to each cost denotes the category of each cost out of the four BS categories.

Improvements in net profit can be made by focussing attention on quality improvement opportunities. Published examples indicate that quality improvement campaigns require an investment of only 10% of the total resulting net gain or increase in profits.

"Cost escalation has been addressed by companies in part by carrying out cost reduction programmes but quality management adds a further, long term, dimension to cost containment and, ultimately, reduction of the cost of non-conformance.

Overall costs will be cut by systematic reduction of cost of non-conformance. Furthermore, the involvement of staff in the whole quality improvement process will increase committment to improvement and the prevention of failures.

Awareness and measurement of the total cost of quality, and the identification of potentials for improvement and removal of traditional deficiencies, leads to the establishment of a complete goal. This is the basis and the beginning for implementing a project - by - project improvement process over a period of years" [4].

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The Skills and Knowledge which will be Required of Successful Cypriot Managers in the Future

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A Cypriot manager should today be looking into the future with much concern because Cyprus and its economy are on the brink of important and sweeping changes which will undoubtedly affect not only all aspects of economic activity but also the cultural environment and almost all aspects upon which the operation of a management entity is based today.

The forthcoming changes, despite any temporary setbacks, are those of membership of the European Union and those of globalisation of economic activity and operations with the minimum of state control and protection. A Cypriot manager with the minimum of hindsight, information and forecasting ability will have by now sensed that the island's economy - albeit with an openess to the outside world - will not be an island's economy in the near future. The political and economic environment is changing and with it he must be ready for a change both for himself as a manager and for what he manages.

In general, the size of operations and of economic activity of firms in Cyprus is small. From a total of 28893 firms in 1989 about 24240 employed less than 5 people and 3792 between 5 and 19. The large firms of more than 100 employees were only 86. The vast majority of the firms with less than 5 employees were, also, run by working proprietors or were family business. Considering the management structures of the Civil Service and other semigovernmental organisations the magnitude of operations are, again, by international standards very small. At the same time there is an indication that management culture is not widely spread in Cyprus due to the family character of firms. Ownership and management go usually together and there is a reluctancy on the part of owners to deligate authority. Management, as far as it is exercised, is a matter of personal or even family connections and this transcends to all aspects of management from production to sales, from personnel management to advertising.

Another idiosyncrasy of the Cypriot firms is that they are usually either export oriented, and these are very few concentrating in the garment and shoe industries, or they are only interested in the local market considering exports as a bonus to be faced with "overnight operation" if and when they come. Local state protection is to be blamed for this, as it inhibits most firms to enter into the fierce international competition.

The political drive to join the European Union has been repeatedly declared but even without this Europe is today as a market a reality and no manager can neglect that. At the same time there is a globalisation of economic activity with border controls, distances and adherence to traditional comparative advantage practices, not being able to exclude an economy to any substantial degree. Most economic activities will have to compete internationally both in terms of quality and price. Within this broad framework the questions which arise are concerned with the environment the manager will work and operate in a few years' time.

First of all state control at national level will be minimal. Import duties and excise levies will have to be abolished or kept at very low levels. The same will happen to export subsidies or government export guarantees. At the same time supranational control will be strong, but if present policies are projected into the future, they will not be protective. On the contrary, they will promote international competition. These controls will otherwise be demanding for high quality and be strict on production and trade practices. The consumer is expected to be sovereign in the future European state in all respects.

Operating in such an environment a firm will be pulled in two opposite but at the same time complementary directions. On the one hand there will be the need for specialisation, be that in production or in services, in order to compete internationally, and on the other hand, there will be the need to operate under an umbrella of related enterprises and firms, be that a group of companies, a conglomerate, an association or a cooperation agreement. Big or small will not matter as long as the right relationship is struck.

The demands and skills and knowledge which will be required of a Cypriot manager in the future are diverse and manyfold. A successful manager will have already sensed what is coming and must have already taken the first crucial steps and be proactive than reactive to what is already within the horizon.

First of all, he has to fight to bring the present management practices to the level of acceptance by society and the proprietors, something which will enable him to manage. This is a taunting task but one to be faced in order to confront the management streamlining and efficiency of European and International firms. The manager will have to convince almost everybody of the benefits of good impartial and scientific management as the basis of a successful business or project. This will not be done by advertising or talking but by good management which will prove successful before bad management or no management at all.

A twofold task will confront the Cypriot manager in the future. This is the definition of the firm's objectives within the framework described above and that of collecting information for his future operations. Both these tasks are of paramount and equal importance. The definition of objectives cannot supersede the collection of information or the other way round.

The objectives of a management unit should be under review on the face of the stream of information which will be needed and which is today available to the manager. Information gathering with today's media is a relatively easy task. What will become increasingly difficult for the manager will be to decipher from the information received which is useful and relevant to his operations. Information about markets, competition and competitors, probable associates and cooperators, international credit, international and national policies etc, is needed in order to make decisions on the size of operations, marketing strategies, prices, quality, etc. His knowledge of the cohesive and singular market of Cyprus will not be enough for international operations.

His ability to receive and handle information will in reality be a manifestation of a new mentality he will have to acquire, not only for himself, but also one he must transmit to the whole management unit. This mentality is that of having flexibility at all levels and all structures with alternative courses of action and operation being part and parcel of any operation from the outset. The comparative advantage a firm has from having a set of objectives and a mode of operation delivered to it from the past, will be lost in European or global context. Thus, a manager should always be ready within the limits of safety to redefine objectives. An export company should not hide away from being engaged in production activities, if the opportunity arises, or selling knowhow or offering consultancy services. This flexibility is not one which will

be grabbed when it comes, but one that a Cypriot manager should always look out for, because the small size or single type/single product operations would be a risk in the future. It is in this context, as well, that association and cooperation should be sought with firms and companies operating in other fields.

Under such open conditions of operation the Cypriot manager will soon discover that when it comes to managing people, his knowledge of local Cypriot culture will not be enough. Most certainly the personnel he manages in Cyprus will gradually include many employees from other cultures. Since his operations will almost definitely extend abroad, or be influenced by what is happening abroad, he will have to be in contact with foreign people almost constantly. He has to develop the skill to communicate directly and constructively with these people and no amount of deligation of authority or of tasks can replace it. In order to optimise the relationships, to know the weaknesses and strong points of people and in order to gain devotion and allegiance, he must have good knowledge of the culture of people and the environment they work in, not to mention laws and regulations, concerning matters related to his operations.

In relation to personnel matters a Cypriot manager will have to take into consideration the social aspect of his operations very seriously. The employment and promotion of women or of handicapped people in his firm will be something that he must give serious consideration. National and international laws and regulations on this should not be taken as obstacles to be avoided or be considered as not applying to his firm but as a challenge to be faced.

Moving away from a family business or a small and protected firm operating in Cyprus into operations internationally will not be an easy task and certainly, it will not happen on its own. Taking into consideration all the characteristics of successful organisations, personnel satisfaction, good reward systems, good use of information, modernisation, use of new and appropriate technology, good investment policies, etc, we reach the safe conclusion that only good managers can achieve them because all the above are attributes of good management.

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Optimisation of a Solar Steam Generation System Heat-up Response

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ABSTRACT

The system presented here, which is part of a solar desalination system, consists of a parabolic trough collector of 3.5 m^2 aperture area complete with a high pressure circulation pump and flash vessel. Preliminary tests on a model show that system heat-up response is critical to system performance and in particular to the start-up energy requirements. An optimisation of design is described which focuses on the selection of flash vessel dimension and capacity. To achieve system optimisation a computer program was developed to model system performance which is described here. This is followed by the analysis of the system response. From this analysis the optimum vessel size and capacity is selected. This vessel reduces the system preheat energy requirement by 57% as compared to the initial design. The system simulation is compared to the actual response of the plant from which is found to be accurate to within 6.5%.

INTRODUCTION

The parabolic trough collector is one of the most preferred type of collectors employed for steam generation. This is because temperatures of about 300°C can be obtained without any serious degredation of the collector efficiency. Typical application of this type of system is the Southern California power plants known as Solar Electric Generating Systems (SEGS). The installed capacity of SEGS to date is 354 MWe [1].

In the model which is described in this paper the collector is employed for steam generation which is used to power a desalination system. The analysis is focused on the steam generation system itself and in particular to the optimisation of its heat-up response and not to the desalination plant.

Three methods have been employed to generate steam using parabolic trough collectors [2]:

- The steam-flash concept, in which pressurised water is heated in the collector and then flashed to steam.
- The direct or in-situ concept, in which two phase flow is allowed in the collector receiver generating steam directly.
- The unfired-boiler concept, in which a heat-transfer fluid is circulated through the collector to generate steam through heat-exchange in an unfired boiler.

The steam-flash generation concept seems to be the best with respect to other steam generation systems due to the superiority of the water as a heat transfer fluid, the small capital cost of the system, the avoidance of any stability problems and guarantee of no fresh water contamination.

STEAM GENERATION SYSTEM DESCRIPTION

The system consists of a parabolic trough collector of 3.5 m^2 aperture area, a flash vessel and a high pressure circulating pump. The complete desalination system is shown in Fig. 1 whereas the steam generation system is shown in Fig. 2. The pumps draws water from the flash vessel which is at saturated temperature. By passing this water through the receiver of the solar col-

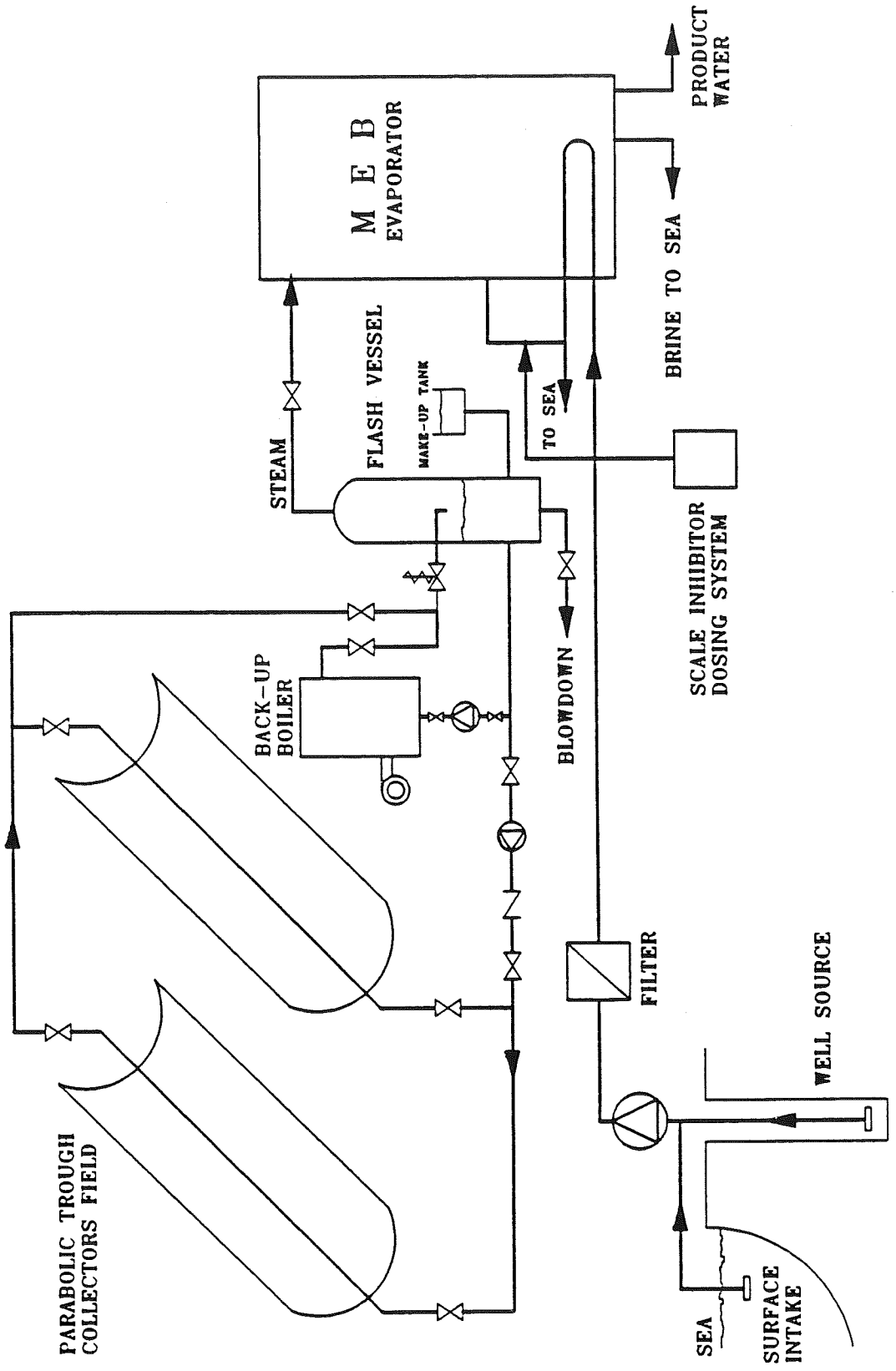

Fig. 1 The complete system circuit diagram

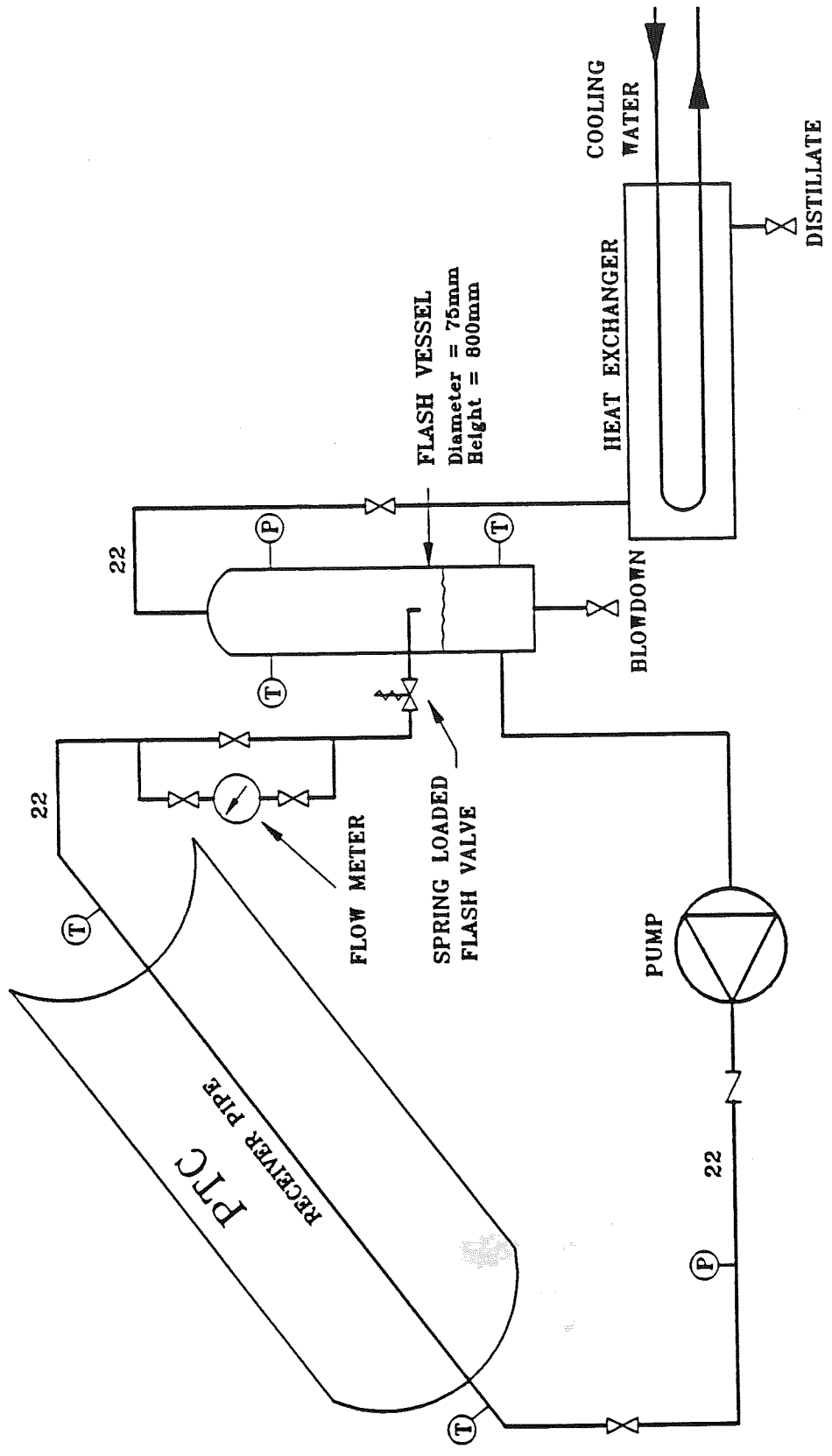

Fig. 2 The complete steam generation system

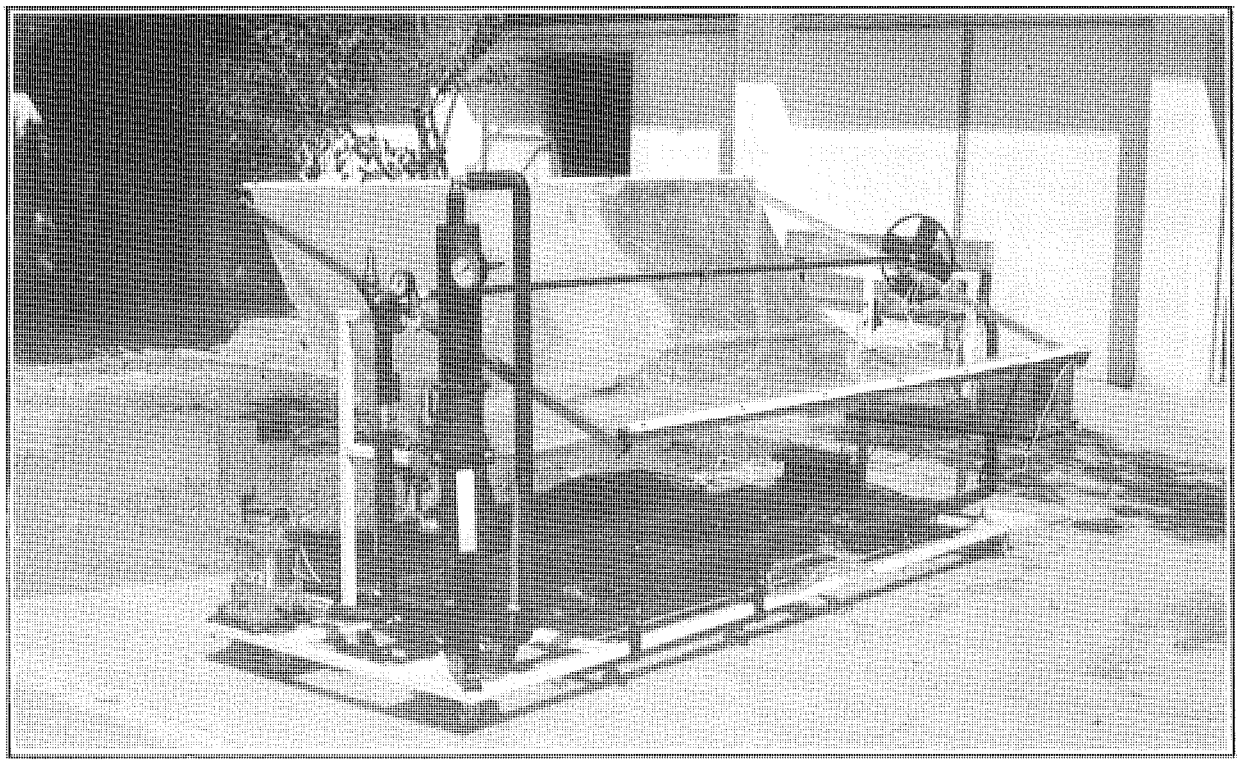

Fig. 3 Photograph of the complete system

lector its temperature is increased. High pressure is used to avoid evaporation into the collector receiver to avoid flow stability problems. This high temperature high pressure water is flashed into steam in the flash vessel after passing through a flash valve. The flash vessel acts as a steam separator. A picture of the actual model constructed is shown in Fig. 3. The specifications of the system are tabulated in Table 1 [3].

As shown above, a flash vessel is used to separate steam which flashes off the hot high pressure water at lower pressure. This is a vertical vessel as shown in Fig. 2, with the inlet for the flashing water located about one third of the way up the side. Standard design of flash vessels requires that the diameter of the vessel is chosen so that the steam flows towards the top outlet connection at not more than about 3 m/s. This is sufficiently slow assuring that the drops of water can fall through the steam in contra-flow, to the bottom of the vessel. Adequate height above the inlet is necessary to ensure this separation. The separation is also facilitated by having the inlet projected into the vessel facing downwards. The water outlet connection is oversized to minimise pressure drop from the vessel to the pump inlet to avoid cavitation. The flash valve connected to the ves-

Table 1 PTC system specifications

ITEM	VALUE/TYPE
Collector aperture area	3.5 m^2
Collector aperture	1.46 m
Aperture-to-length ratio	0.64
Rim angle	90°
Glass-to-receiver ratio	2.17
Receiver diameter	22 mm
Concentration ratio	21.2
Collector intercept factor	0.9506
Maximum optical efficiency	0.654
Tracking mechanism type	Electronic
Mode of tracking	E-W horizontal
Mass flow rate	0.042 kg/s

sel inlet is spring loaded and adjusted by changing the spring stiffness (compression). The diameter and height of the initial vessel as obtained by the above are 75mm and 800mm respectively. The suggested vessel diameter gives a mean steam velocity equal to 0.6 m/s.

SYSTEM PREHEAT ENERGY EVALUATION

On cold start of the system and before any useful energy is used for steam generation the system must bring the circulating water to the saturation temperature i.e. at about 100°C. Moreover, various parts of the system such as the piping, the flash vessel and the circulating pump absorb energy to heat up at the same temperature. The amount of energy required to preheat the system depends on the heat capacitance of the various system components and is called capacitance loss.

The preheat energy can be calculated by recording the temperatures at various points of the system. The measurement point of each thermocouple is shown in Table 2.

Table 2 Thermocouple measurement points

Thermocouple number	Temperature measurement point
1	Collector outlet
2	Collector inlet
3	Flash vessel bottom
4	Flash vessel top
5	Ambient

The temperature readings are shown graphically, together with the solar radiation available, in Fig. 4. The system is said to be at the end of the preheat cycle when the temperature at point "4" of the system reaches the saturation temperature. From the data shown in Fig. 4 this is achieved after 5.4 MJ of energy is lost. As it can be seen from Fig. 4 the temperature at the top of the flash vessel, point "4", is slowly increasing by conduction from the bottom of the vessel until the collector outlet temperature reaches 100°C. When this happens the temperature increases more rapidly but some more energy is needed, about 1.3 MJ to preheat this part of the vessel. The steam produced during this period is condensed on the relatively cold vessel walls until their temperature reaches the saturation temperature at which point the preheat cycle is completed and the system starts producing useful steam. The temperature difference between points "3" and "2" is attributed mainly to heat losses from the pump body. The temperature at points "3" and "4" are stabilized somewhat below the saturation temperature due to heat losses from the flash vessel insulation. Flash vessel with 75 mm diameter, 800 mm height and 1.5 litres water content was used for this experiment.

SYSTEM REFINEMENT

From the test results shown in Fig. 4 it is evident that the system preheat energy requirement (thermal capacity) could be reduced. This can be achieved by reducing the system's water volume since a large percentage of the preheat energy is used as sensible heat of the water, both circulated and contained in the flash vessel. It can also be achieved by optimising the flash vessel dimensions and construction in order to lower the thermal capacitance and losses. Therefore the aim is to reduce the total water mass in order to reduce the preheat energy. For this study two problems are foreseen:

- the mass of the circulated water (water contained in the pipes) is constant and can not be varied.
- the reduction of the water mass in the flash vessel may lower the system performance since a large proportion of make-up water would lower the temperature of water in the flash vessel with consequent reduction in the system steam production.

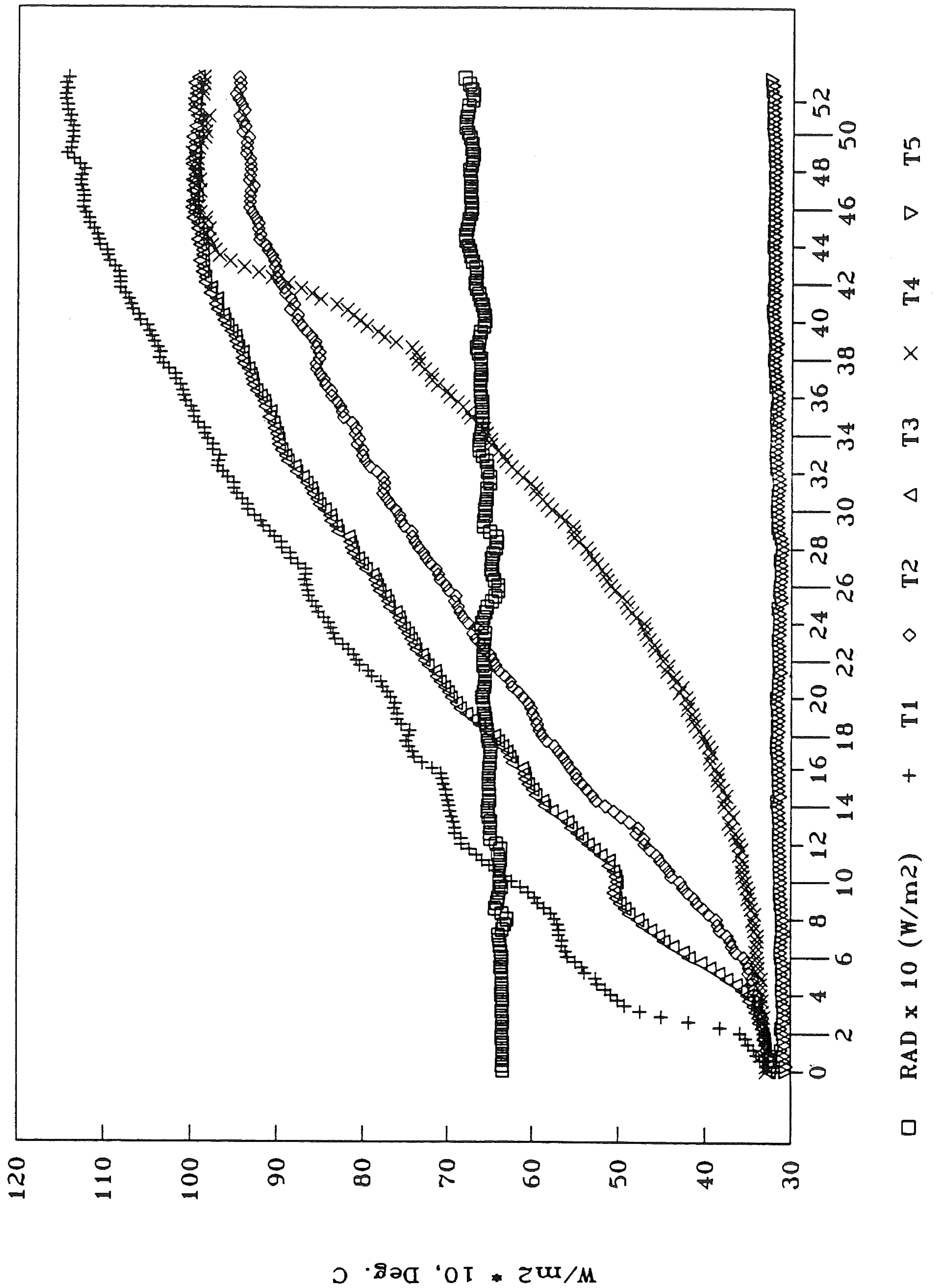

Fig.4 Preheat cycle graph

Another conclusion drawn from the first test performed is that the height of the vessel does not have to be that great. This is because the velocity of the steam is already very small compared to the maximum allowed and also possible "contamination" of the steam with carried over water droplets is not serious as the water in the system is distilled. This will have no diminishing effect on the overall system performance. Also a reduced height vessel will imply less mass to heat with consequent reduction on the capacitance losses.

Another possibility which can be investigated with respect to the system refinement is the use of the flash vessel as a storage vessel. This will have the effect of starting the operation in the morning at a higher temperature but also with bigger water volume to heat up.

From the above discussion it is evident that the flash vessel dimensions and capacity need to be decided after some modelling and that the flash vessel optimisation depends on many inter-related parameters. Therefore there is a need of writing a computer program for the optimisation of the vessel. The simulation program written is called "FLASH". The program takes into account, in addition to the sensible heat, all the major losses from the system i.e.:

- Losses from the flash vessel body
- Losses from the pipes
- Losses from the pump body
- Capacitance losses of all the system components

The program considers also the losses during the night-time assuming a starting temperature, of the water in the vessel, equal to the saturation temperature so as the effect of using the vessel as a storage is investigated.

The program considers a constant radiation input and a constant ambient temperature throughout the day. Therefore the system performance can be investigated theoretically independently of the weather conditions.

The program flow chart is shown in Fig. 5 from which it can be seen that after the night losses are considered the initial flash vessel water temperature is determined. This is followed by the determination of the input energy from which the thermal losses are subtracted. The remaining energy is used either as a preheat or, after the preheat cycle is completed, to produce steam. The time step used in the program is one second. The program can be used to model the behaviour of the system during preheat and to determine the daily steam production of the system.

Table 3 Program «FLASH» input data

PARAMETER	VALUE
Solar radiation	500 W/m^2
Mass flow rate	0.042 kg/s
Flash vessel water content	0.6 kg
Aperture area	3.5 m^2
Collector efficiency	0.638
Ambient temperature	30°C
Mass of circulated water	4kg
Flash vessel outside diameter	94mm
Flash vessel inside diameter	51mm
Flash vessel wall thickness	1.2mm
Flash vessel height	0.6m
Pipes UA-value	0.93 W/K
Pump body area	0.12 m^2
Insulation conductivity	0.035 W/mK
Flash vessel and pipes mass	10 kg
Pump mass	20 kg

The input data to the program is shown in Table 3 whereas the dimensions of the different sizes of flash vessels considered are shown in Table 4. The results from the program are shown graphically in Fig. 6 where the first hour and the daily production of steam are plotted against the vessel capacity. The vertical lines represent dif-

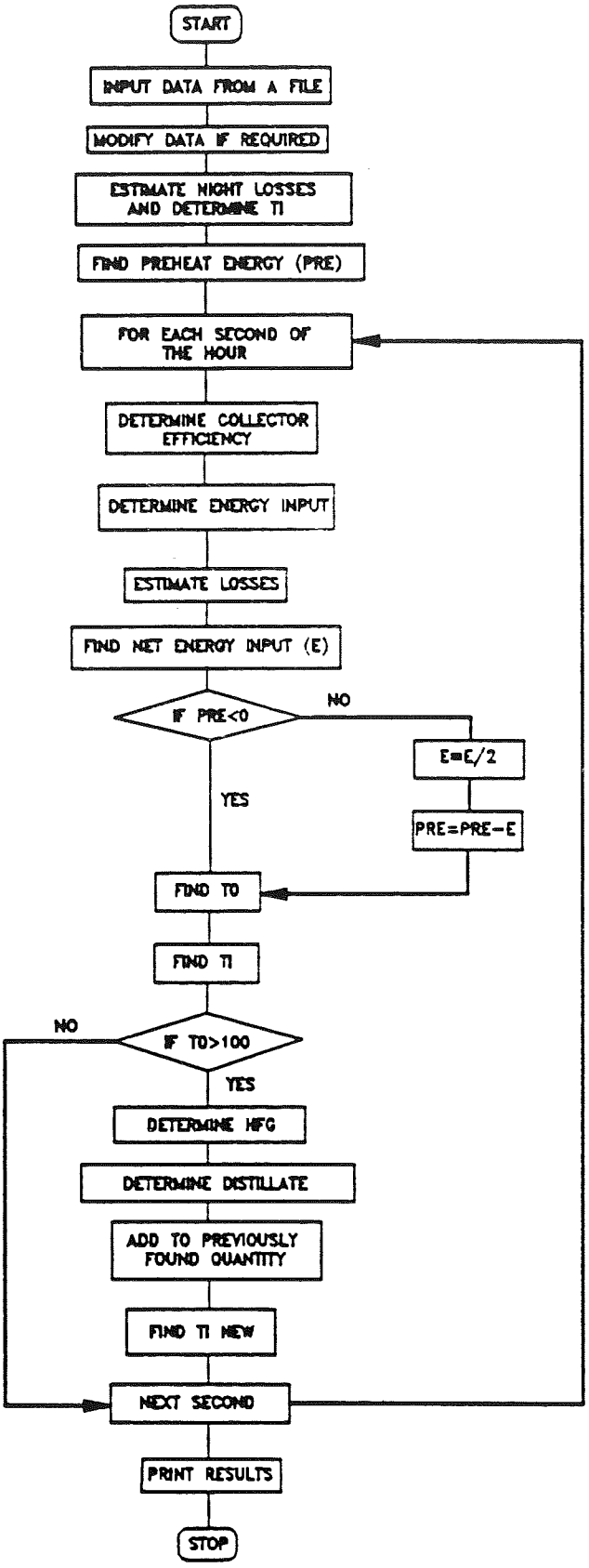

Fig. 5 Program "FLASH" flow chart

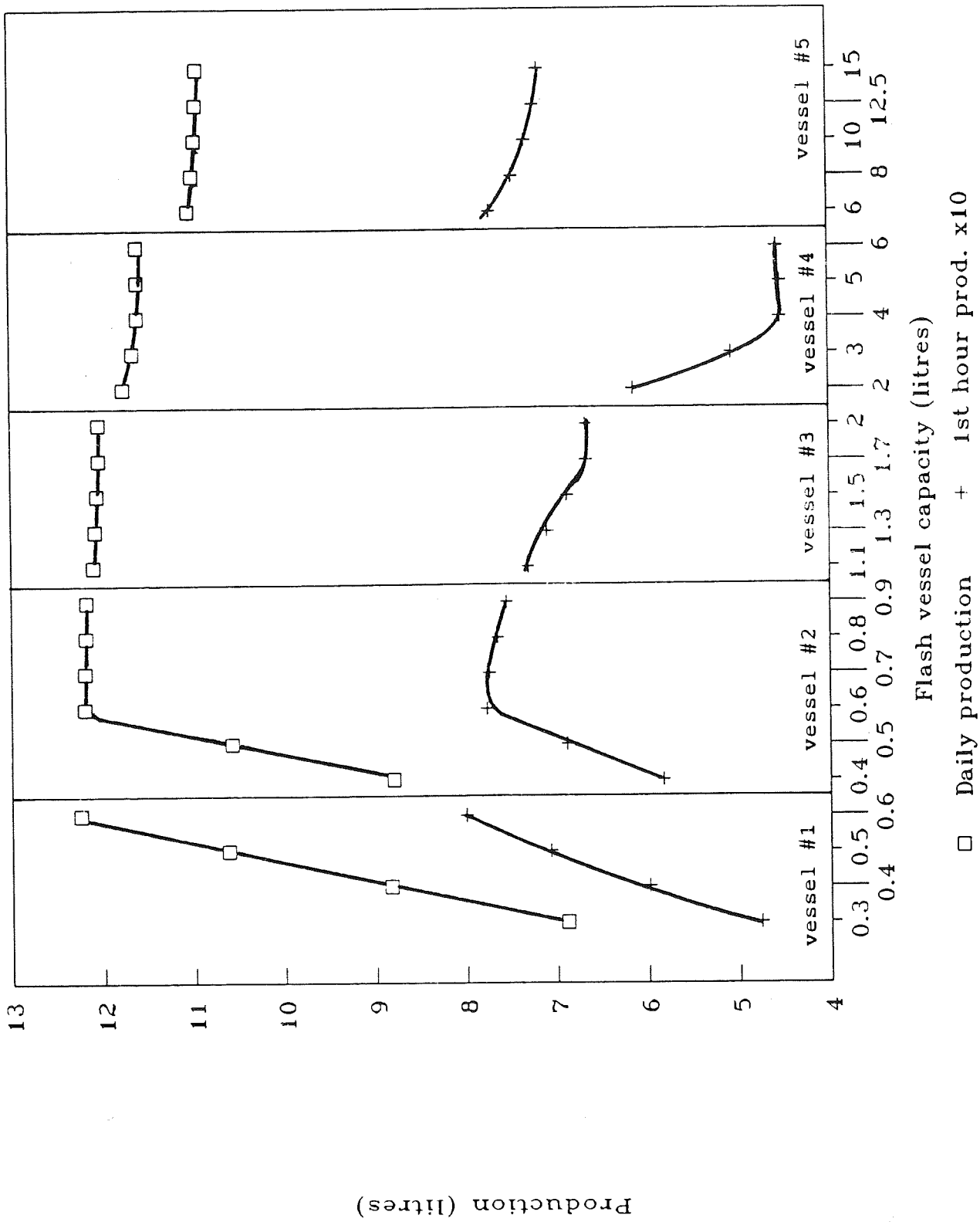

Fig. 6 Steam production from various flash vessel dimensions and capacities

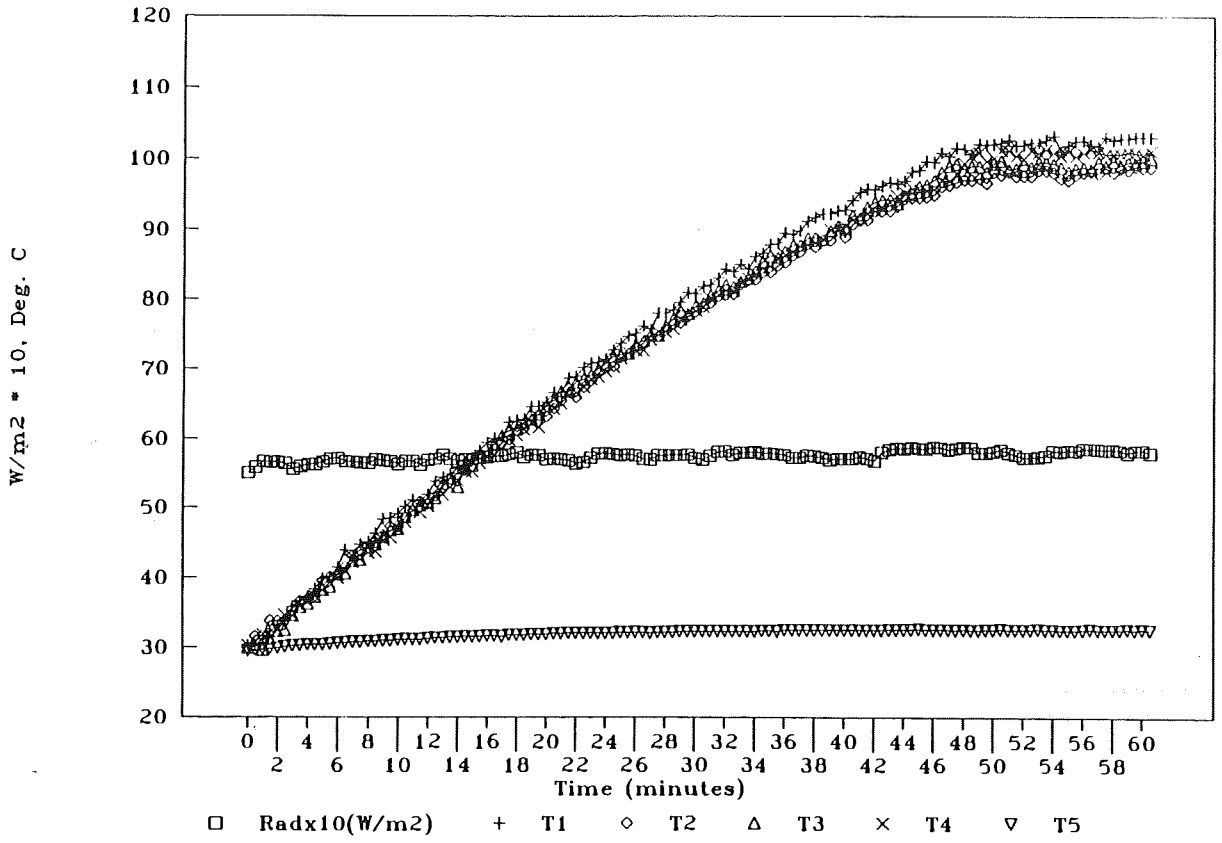

Fig. 7 New system preheat cycle graph

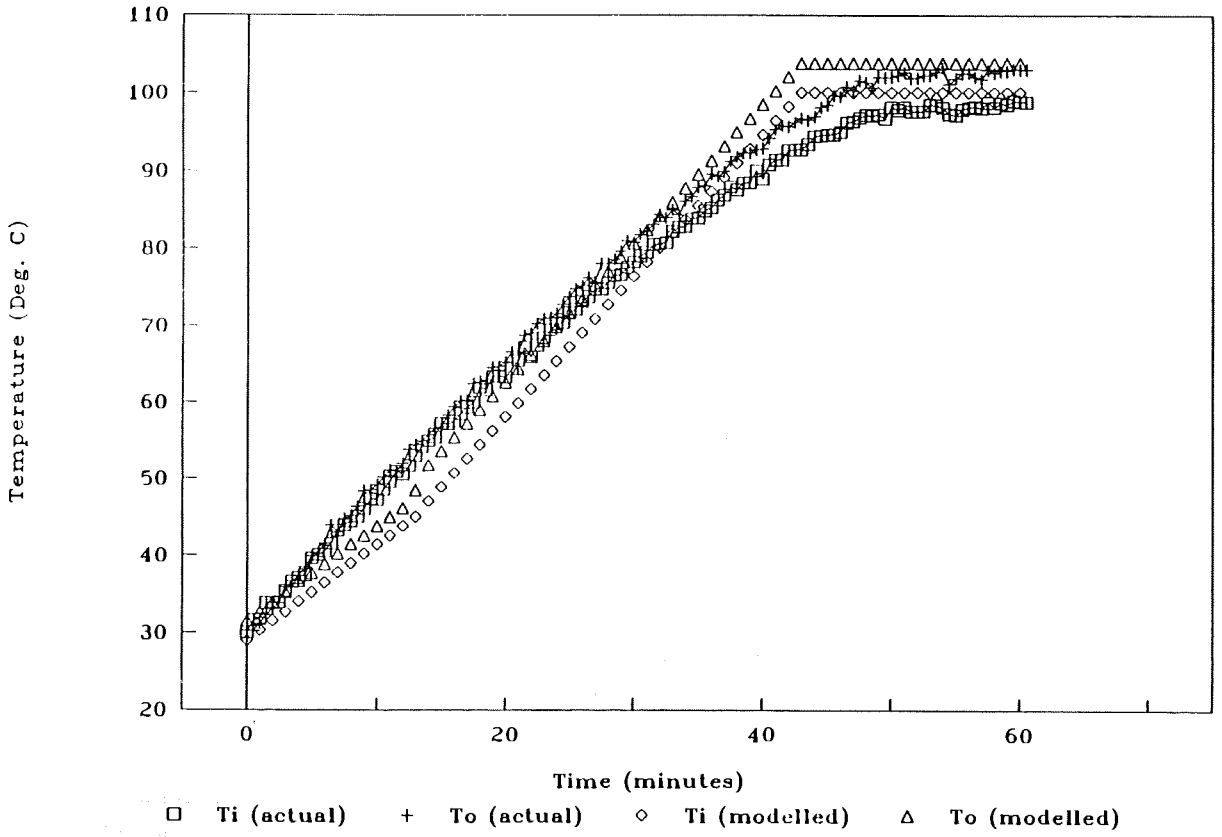

Fig. 8 Comparison of actual and predicted heat-up response

ferent flash vessels according to the sizes given in Table 4.

Table 4 Flash vessel dimensions

Flash vessel number	Outside diameter (mm)	Inside thickness (mm)	Wall thickness (mm)	Vessel height (m)	Water content (kg)
#1	94	51	1.2	0.6	0-0.6
#2	105	65	2.0	0.6	0-1
#3	115	75	2.5	0.8	1-2
#4	140	100	3.0	1.1	2-6
#5	190	150	3.5	1.3	6-15

It can be seen from Fig. 6 that the highest performance, for the 3.5 m^2 aperture area model constructed, occurs at no storage condition for vessel #1 with water content of 0.6 litres. This vessel also gives the greatest production for the first hour which implies a reduced preheat energy requirement. Therefore the final vessel adopted is similar to the one shown in Fig. 2 but with 600 mm height and 54 mm diameter. This is also the least expensive solution.

Due to the diversity of the various parameters considered the above result is not a rule. Therefore similar analysis would have to be performed in other cases taking into account also the economics. This is due to the fact that a bigger vessel may increase the system production but the benefit will have to be more than the difference in extra cost of the vessel.

NEW SYSTEM PREHEAT ENERGY EVALUATION

The preheat response of the system with the new vessel installed and with optimum water content is shown in Fig. 7. From the results obtained (as shown in Fig. 7) only 3.8 MJ are now required to preheat the system in comparison to 6.7 MJ required for the original vessel. Therefore the preheat energy required is reduced by 57%. It must be pointed out here that in addition to the 0.6 litres of water contained in the flash vessel there are 4 litres of additional water contained in the pipes which also need preheating.

EVALUATION OF MODEL ACCURACY

The accuracy of the modelling program "FLASH" can be determined by comparing the actual system preheat response presented in Fig. 7 to the modelled response. This is shown graphically in Fig. 8 where it can be seen that there is a small difference between the two, of the order of 6.5%, with respect to the preheat cycle completion time and with approximately the same shape of graphs. The difference in the shape of the model curve at the beginning is due to the fact that in the program the required capacitance energy is evaluated at the beginning. During this period half of the input available energy (after the losses are substracted) is considered to be used for capacitance losses until all the energy estimated originally is covered.

CONCLUSIONS

The optimisation method presented here proved to be effective and accurate. A marked reduction of preheat energy by 57% is realised by the optimum vessel size and capacity suggested by the method shown. This vessel gives also the greatest daily steam production. The model is found to be accurate to within 6.5% which is considered very adequate.

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Knowledge and Skills for Effective Supervision

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INTRODUCTION

This article will attempt to highlight the knowledge, skills and personal traits which supervisory staff should possess to meet successfully the challenges of education in the decade of the 90's, on the eve of the twenty-first century.

For the purpose of this article a "supervisor" is an educator who may or may not have administrative duties but s/he is responsible for Curriculum Development, Instructional Development and Staff Development. An educational supervisor usually assumes four major roles: group leader, evaluator, co-ordinator and consultant (see Figure 1 below).

KNOWLEDGE

An educational leader should possess academic knowledge, knowledge of the societale and culture, and knowledge of his/her role at any given situation.

Academic knowledge begins with a degree or a diploma in education or any major field of study. To enhance this knowledge supervisor-aspiring personnel should acquire a good grounding in learning theory, educational psychology, philosophy of education (curriculum and instructional development) and educational sociology. Supervisors should study these fields on a local, national and international level if they want to have a deeper and fuller view of the developments of education.

Moreover, supervisory staff should seek to become acquainted with the culture of classroom, school and community at all levels. This type of knowledge is very important when it comes to setting goals, objectives, choosing mode of operation, nurturing motivations and instituting remarks.

Supervisors should also seek to clarify their role with each appointment depending on the job they are assigned to. In other words they should find out whether their duties involve co-ordination, group leadership, and evaluation in instructional development, curriculum development and staff development. It is also useful to find out to whom they are accountable to and what are the legal implications which derive from their duties.

Supervisors need to update their knowledge in all three areas examined: academic, role, and societale otherwise, knowledge becomes stagnated and outdated. They should keep abreast with research in their specialisation by attending professional seminars, conferences and training courses or reading the relevant literature and professional journals. Moreover, the type of learner changes rapidly because of social, political, technological and media influences. Unless supervisors keep track of changes and significant influences, they run the risk of becoming inefficient.

SKILLS

Dormant, inert knowledge, no matter how wide-ranging, is as useless and ineffective as lack of knowledge. Thus supervisors need various skills which would enable them to tap and activate the hoard of their academic and professional knowledge.

Today our society, on the threshold of the twenty-first century, needs according to Pearson (1990) "multi-ability" teaching staff at all ladder positions.

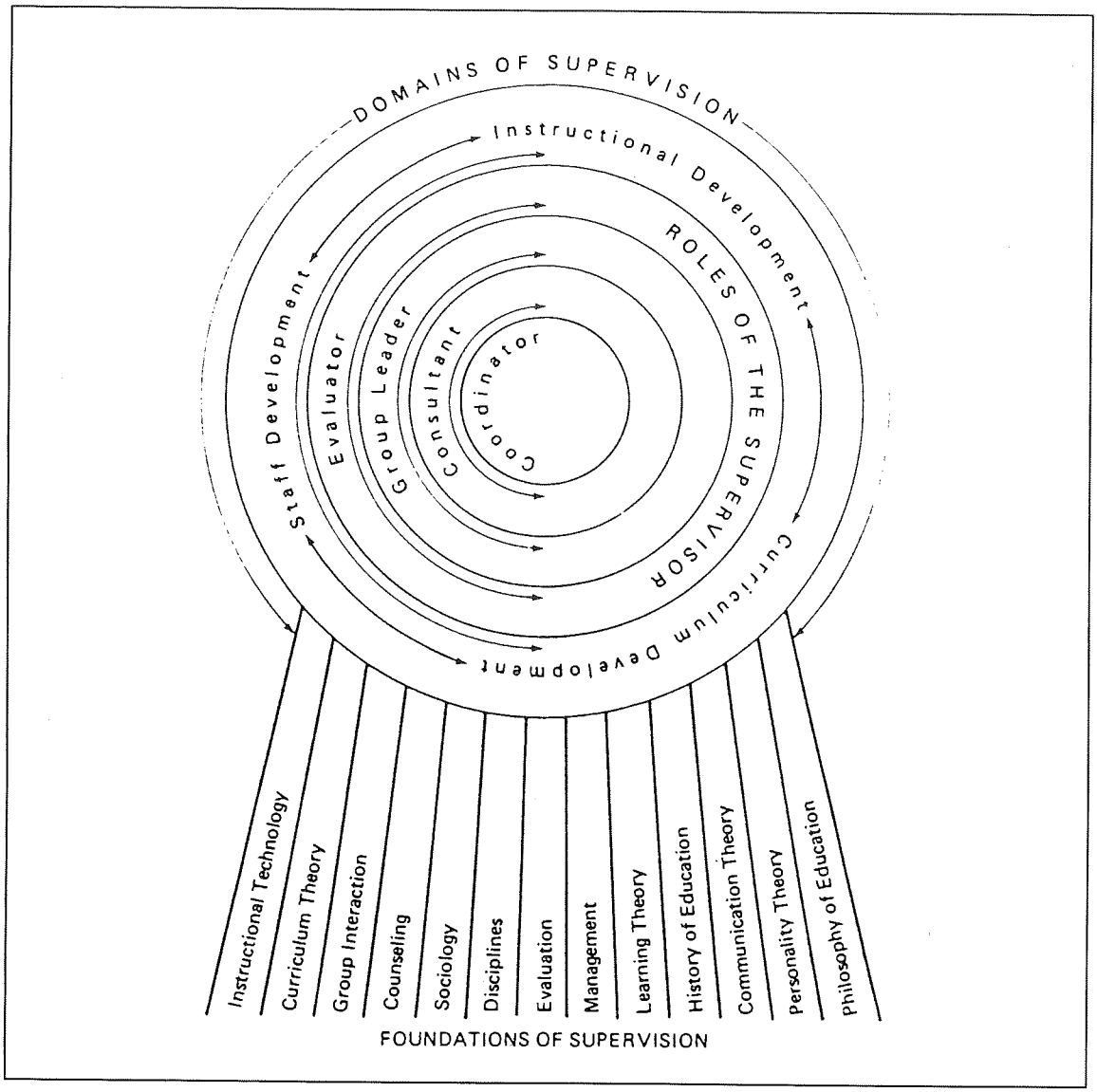

Fig. 1 A conceptual model of supervision (Oliva 1993, p22)

Although, on the whole, there is some agreement regarding the type and scope of knowledge required from a supervisor, there is less agreement as to the skills needed for the role of efficient supervisor. However, Katz (1955) Mann (1965) quoted in Alfonso et al (1984) seem to agree that supervisory staff need skills in the technical, human and administrative (managerial) domains. Moreover, Alfonso et al (1984) and Oliva (1993) underline the mix of these abilities as key to a supervisor's competence. Indeed, it seems that [i]t is the selection and application of an appropriate combination of skills that makes instructional supervision effective; the mix is of far greater importance than the individual skills" (Alfonso et al, 1984, p.38).

Technical skills are the cluster of skills which are unique to the teaching profession alone and which distinguish it from other professions. They are skills developed by the practioners of teaching through exposure to theory, practice, various levels, school cultures and research findings. Pajack (1993) argues that "the technological, and social realities of the 1990's seem to require the educational leader be a "teacher", both in the sense that they lead and in the sense of genuine in-

volvement by teams of teachers in creating learning-focused schools" (p.162).

Another term used for the educational leader is that of the "master teacher" thus highlighting the analogy between the co-operative and collegial spirit which bound together the craftsmen and masons at all ladder positions and their master mason/craftsman of the past with the co-operative and collegial spirit needed in an educational environment. As Pajack (1993) argues school should become a learning focused organisation than a teaching focused organisation. The learning process becomes a more important process at all levels. It is a more democratic and co-operative approach which should underline the relations of teaching, learning, and supervisory staff. Learning becomes a two-way process for supervisors and staff, students and staff for they learn from each other. Thus the end result is a truly co-operative achievement.

The effective educational leader should be skilful in human skills, that is to say, to have the ability to work with people and through people. These interpersonal qualities seem to me to be more inborn than acquired. There is no doubt that human skills can be enhanced by training and theory. Educational leaders should be excellent communicators for like salesmen they have important wares to sell. Their effectiveness and professional survival would depend on their ability to sell their vision, their philosophy and their model of leadership.

Educational leaders used to mandate their policies and models. But, nowadays, people have come to distrust autocratic leadership, they tend to believe in democratic leadership and usually appreciate empowerment which is more likely to lead to true co-operative and collegial spirit. Effective leaders should be able to convince the agents around them to share their vision, goals and objectives. I would agree with Hill's motto that "people support what they help create" (1992, p.v.). As a partner you share both the praise and blame.

Supervisory staff should possess managerial skills i.e. skills which will permit them to create relationships and make decisions which will facilitate achievements and the goals of the organisation. Good managerial staff should know how to employ a needs assessment tool; make decisions after investigating all possibilities/ learn to adopt the feasible and practical instead of the ideal, and plan ahead. Another powerful tool to apply is discipline which should be corrective but not punitive.

Moreover, an effective supervisor never acts on impulse or in anger. Listening skills are needed badly at all lines of supervision as we catch ourselves on the run, plagued by time-limits.

Additionally, the spread and influence of media and technology to all walks of life including education makes it imperative for the educational leader to acquire the necessary knowledge and skill of using and applying these modern tools both to all teaching and learning levels including teacher development, teacher evaluation, curriculum development and curriculum implementation. The decade of the 1990's would surely be relying more and more on technology in the educational field.

Another aspect of managerial skills is time management. Supervisors should learn how to manage time: to plan, utilise technology and human resources at their disposal, and delineate power. These are only a few of the techniques which managers can employ to help them go through all the various chores of their profession. It is not unusual for supervisors who fail to manage time to find themselves smothered up by chores-something which invariably leads to inefficiency and finally to either burnout or suicide.

CHARISMATIC PERSONAL TRAITS

As noted earlier, the ability to mix these skills effectively is the keystone to success in supervisory positions for it leads to harmonious relationships which result in high productivity, effectiveness and success. However, there is no ready-made prescription of how to mix these skills. As Oliva (1993) points out "more and more we are coming to realise that there is no single approach to supervision that guarantees success under all conditions" (p.576).

Naturally, one wonders how can a supervisor be successful in an age which demands multiple-instructional strategies for multiple student learning styles (Pearson, 1990)? How can a supervisor be successful in an age which presents so many models for educational leaders i.e. democratic educator, organisational change agent, corporate visionary, master teacher-to mention just a few of the fad terms applied (Pajack, 1993, p.161). How can educational leaders grope their way through all these philosophical and educational theories and prototypes with which they are being bombarded? What are the anchors for self-confidence, self-esteem, and self-realisation? In my opinion the effective supervisor should possess certain charismatic traits like vision, common sense, a sense of fairness and a touch of humanity.

A key charismatic trait in educational leadership is vision. Vision to be successful should be a shared vision. As Fullan (1993, p.127) explains "shared vision, which is essential for success, must evolve through the dynamic interaction of organizational members and leaders." History abounds in examples of charismatic leaders with visions who convinced others to share it. Their disciples and followers struggled and even sacrificed their lives for their beliefs. An educational leader with a vision can inspire, motivate the staff, the students, the parents and the authorities to share his/her vision.

Another charismatic quality is the possession of and the ability to apply, common sense. In my opinion, this is the leader's measuring stick, the compass or better the "nous" (mind) to use one of Anaxagoras' philosophic terms, in other words the guiding force behind every decision. Common sense would help them sail through Scylla and Charybdis whenever difficult situations or conflicts emerge. It would help them go for the practical and workable instead of the ideal and perfect.

Another vital feature of effective leadership is being fair. Being fair means treating all staff and students as equal, not being biased in decisions, not favouring and discriminating among staff, being fair in staff evaluation or in rewards whether intrinsic or extrinsic. In order to avoid creating a negative environment of favouritism and conflict a supervisor, like the wife of Caesar, should not only be fair, but appear to be fair. Being fair fosters harmonious relations which in turn enhance co-operation and congeniality.

Above all a leader should be humane and sensitive to human beings, whom he is supposed to inspire to work together for a desired outcome. A humane leader is ready to "bend a rule" in order to do justice, otherwise, s/he might end up demanding "a pound of flesh". The further automation and technology are encroaching on human domains, human activities and human relations, the more the need for caring, and humane feeling in our school environments (Noddings, 1993). A touch of humanity will avert ineffectiveness, despair, burnout and suicide among the staff and students. Humane environments would certainly nurture caring human beings not monstrous human beings.

CONCLUSION

We could, indeed, continue listing skills and knowledge, which we deem, imperative for effective supervision, or amass quotations from educational research and philosophy, or keep using the latest im-

pressive fad-terms, but we could not come up with a formula or a prescription which could work in any given situation or in any individual case of supervision.

What then could the great numbers of supervisory staff in education do? In my opinion they should turn to Socrates, the great teacher of ancient times, and adopt his motto: "Know thyself". In other words they should get to know their strengths and weaknesses. They should rely on their strengths and try to improve on their weaknesses. Like the Socratic prototype, they should keep asking questions, investigating problems, searching for the true nature of things and dedicate themselves to supervision.

Like good salesmen they should make a market-research for the reactions of the community (learner-teacher-parent-authorities) to whom they intend to sell their education ware. "Take the feel of the market" is a very powerful tool in the process of selling successfully their educational model, vision, dream, policies and goals.

Lastly, supervisors should have faith in their goals and themselves. When they run aground and they discover that all the academic knowledge and acquired skills and training are not enough, then they should employ instinct and fall back on internal resources. Effective supervision requires above all dedication. It taps all one's inborn and acquired resources.

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Reverse Engineering - and Rapid Prototyping Techniques in Medicine, Geology, Animation, Design and Milling Industry

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ABSTRACT

This paper presents a new software function based on the recent Computer Aided Design, Computer Aided Manufacturing (CAD/CAM) and Rapid Prototyping technology, which has succeeded not only in visualising precise 3D-images of a human body on workstations, but also in producing resin prototypes and simulating medical surgery.

A major problem in medical imaging is the three dimensional reconstruction from parallel cross sections (Reverse Engineering). Such 3D models are used for surgery planning, prosthesis milling, radiation therapy planning and volumetric measurements. In the preparation of complex bone surgery, it becomes a common practice to make solid models of bone structures. Surface generation, contour lines generation, triangulation and volume generation, will be explained for the different operation levels with respect to CAD/CAM-, Finite Element Systems (FEM) and stereolithography (Rapid Prototyping)/1-5/.

INTRODUCTION

The utilization of the Computer Graphics technologies in order to visualize, analyze and reproduce human body is becoming crucial to the present medical field. 2D-Data which are generated by medical imaging systems, such as X-Ray Computerized Tomography (CT), Magnetic Resonance Imaging (MRI) and Ultrasonic Systems are often not comprehensive enough for the surgeons to analyze the conditions of their patients effectively /1,2,3/. To overcome the disadvantage we propose a solution to the reconstruction problem, the *Delaunay, Reconstruction*, which is based on the Delaunay triangulation, a well studied data structure in computational geometry /6/.

THREE DIMENSIONAL RECONSTRUCTION BY DELAUNAY-TRIANGULATION

Our method produces a polyhedral model from a set of parallel contours. Unlike the voxel method /3/, we do not use equally shaped volume elements to fill the space between adjacent cross-sections, but tetrahedra that are adapted to the contour shape.

The Delaunay Reconstruction has the following properties:

- It gets direct to a 3D polyhedral representation composed of tetrahedra.
- The property of connecting contours on adjacent planes directly by triangles avoids the need for anti-aliasing or interpolation steps, especially for large cross-section distances.
- Unlike surface oriented methods, we are able to treat complicated objects presenting multiple contour branching and hotels automatically (Fig.3 and Fig.4)
- We achieve a considerable data reduction compared to other volume oriented

methods (voxel). Real time display of reconstructed human organs is therefore possible on standard graphic workstations. This feature may be interesting for the design of models used in virtual reality, where rendering speed is crucial.

– The tetrahedral structure can be used for applications like simulation of motion or finite element methods.

SURFACE GENERATION FOR CAD/CAM-SYSTEMS

The tooling and molding industry currently models the molding workpieces mathematically through CAD/CAM-Systems. Unfortunately the analytical description of such objects is not sufficient for practical applications. Here the space and time complexity must be increased to achieve the approximation and interpolation necessary.

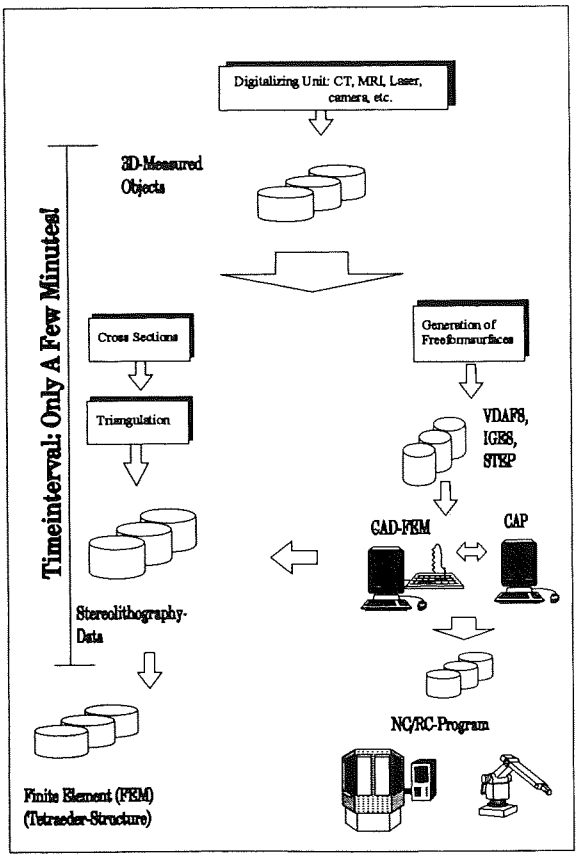

Fig.1 Reverse Engineering, rapid prototyping in CIM

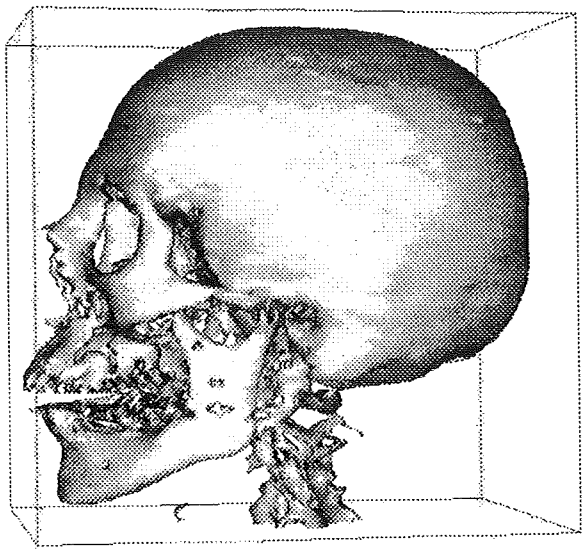

Fig. 2 A skull from 113 CT images

The computation performance of existing CAD/CAM-Systems is insufficient for the processing of such data. A data reduction is required to solve this problem. A data reduction of more than 80% can be achieved depending on the complexity of the workpiece by computing splines curves and spline surfaces and using the following algorithms:

– Bicubic Bezier,

– Polynomial representation (Coons),

– B-Spline,

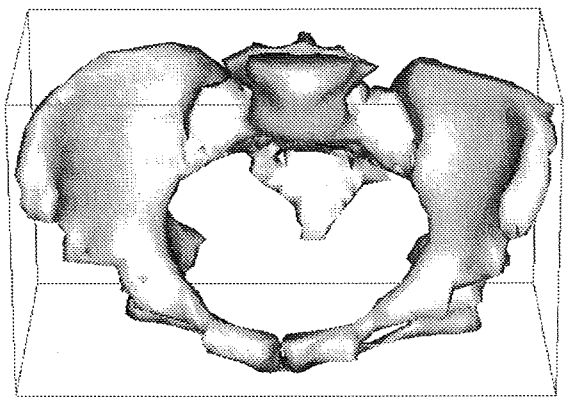

Fig. 3 A human pelvis from 23 MR images

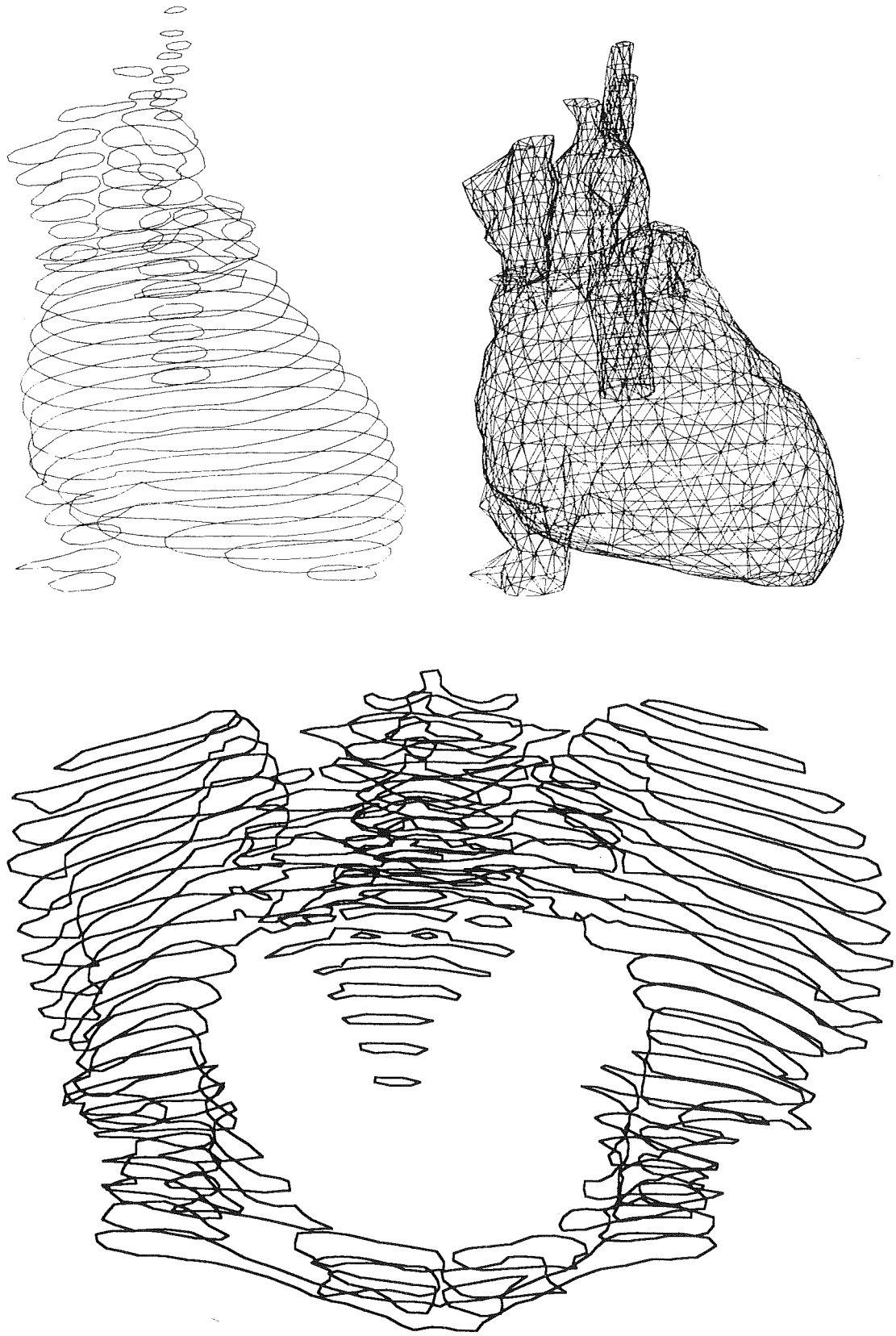

Fig. 4 The generated contours of human heart and pelvis. The triangulated structure (volume-structure) of the heart is illustrated too.

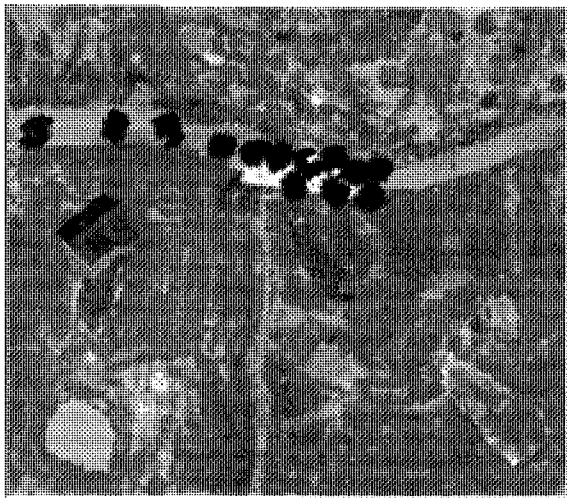

Fig. 5 The laser intensity of a geographical model. A house, the trees near the river and the mountains can be identified here.

Fig. 6 The calculated high lines of the digitilized geographical model

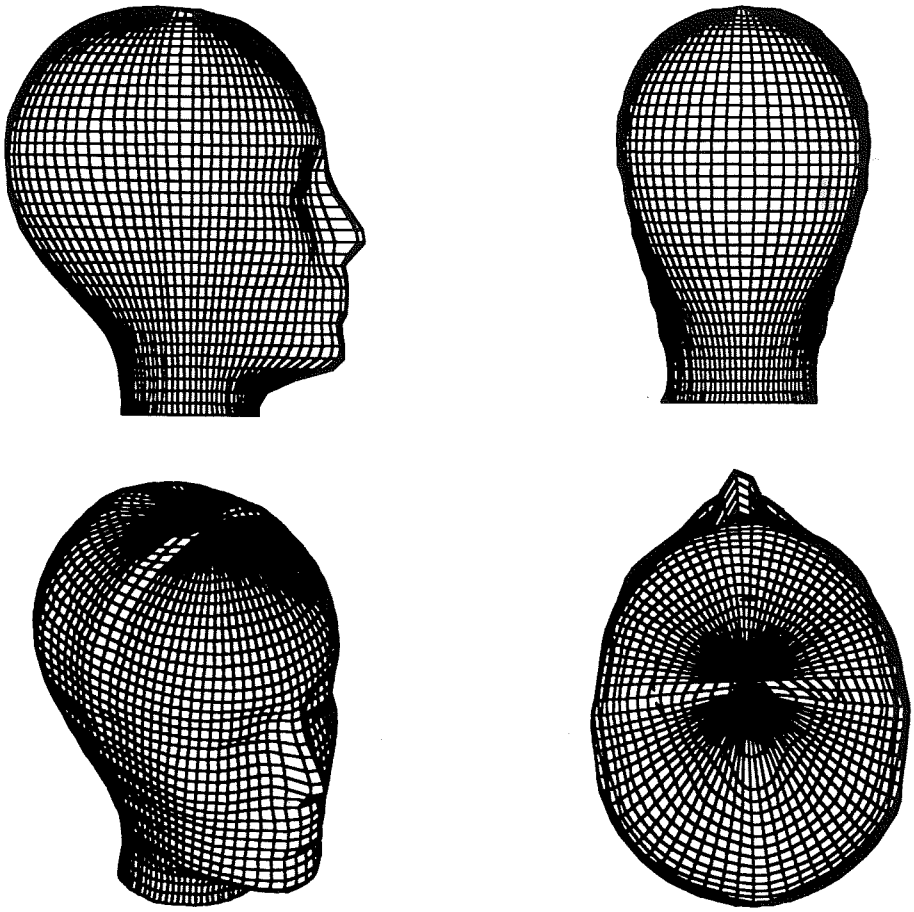

Fig. 7 The four views of the CAD 3D-reconstruction of a glass head

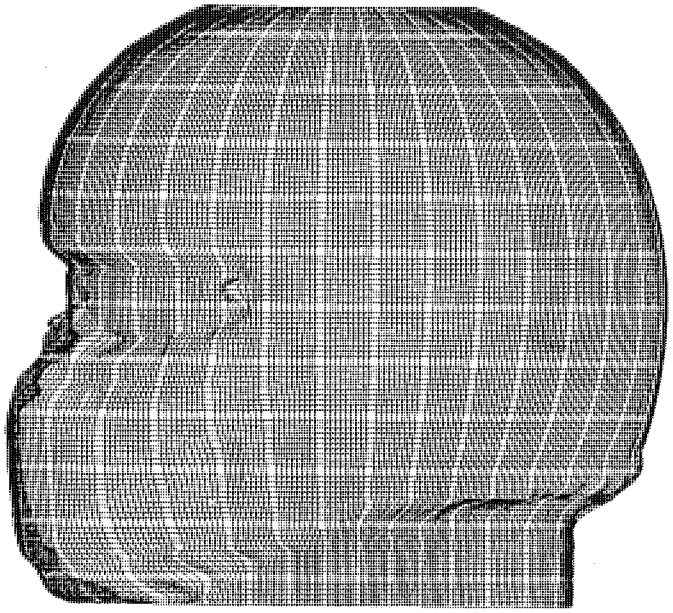

Fig. 8 The reconstructed 3D-motorcycle helmet (Freeform-Surfaces-Structure)

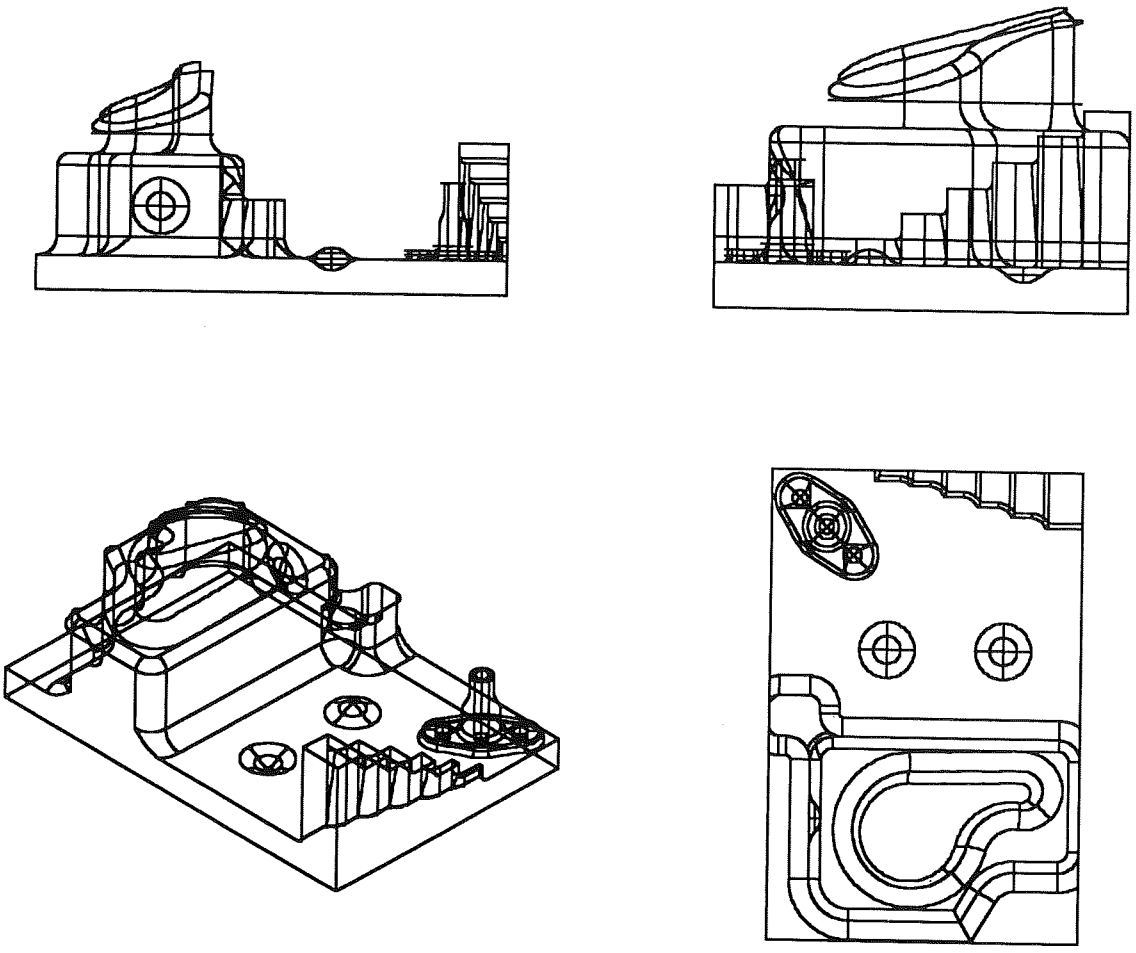

Fig. 9 The reconstructed four views of the test object (volume oriented structure)

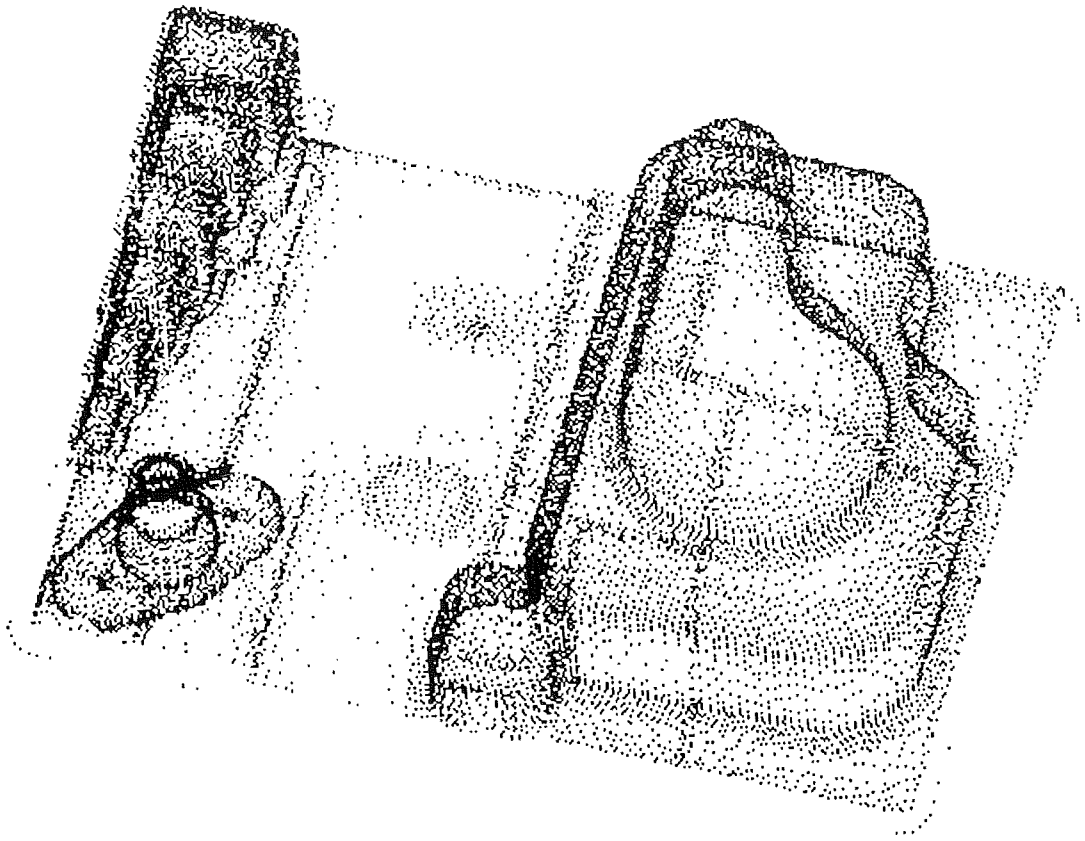

Fig. 10 The digitilised 3D-points of a test object

– Non Uniform Rational B-Splines (NURBS) representation.

The output of this software functionality can be processed by all 2D/3D-oriented CAD/CAM or FEM-Systems /7,8/. For the data transfer within CAD/CAM-Systems the following standard interfaces are available: IGES, STEP, DXF and VDAFS /9/. The usefulness of the tetrahedra structure has even been shown in a computer simulation of childbirth /10/.

IMPLEMENTATION

The entire software functionality (Fig.1) is implemented in the programming language "C" and can be used on UNIX/X11 Motif Workstations or PC's. It is, at this time, an ideal prototype for the medical model, design and milling industry /6-8,10/.

Fig. 2 shows a reconstructed skull from a CT Cadaver study (From the Chapel Hill Volume Rendering Test Data Set available at cs.unc.edu.). The contours on 113 cross-sections were extracted by simple thresholding, so that the process from CT-data to the 3D model was fully automatic. The model contains about 70000 surface triangles. Fig. 3 and 4 shows a human pelvis from a set of 23 MR images. The contours were extracted manually. In spite of the large cross-section distance (8 mm vs. 1 mm in-slice resolution), the model is relatively smooth. Fig.5 illustrates the laser intensity of a digitalized geographical model, seen in Fig.6 as a calculated reconstructed high line (cross-sections) model. It is shown in Fig.8 the results of 16-overlapping laser-digitalized views of a glass head. The motorcycle helmet, in Fig.9, is another demonstration of the

processing of 3D-digitalized objects to volume oriented CAD-structures. The last two figures illustrate an example from industrial milling processing. A CAD visualisation of the reconstructed object from four views is shown, the last figure presents the input (3D-digitalised points) of the object for the developed software. All of these objects have been processed using stereolithography.

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Zero Energy for the Mediterranean Houses

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ABSTRACT

The study aims at the optimization of the regulatory systems inherent in domestic architecture through choice of orientation, building materials and the use of natural resources of energy, to achieve comfort conditions without the need for mechanical heating and cooling for the Mediterranean climate.

The paper deals with the optimization of a specific house type in Cyprus, to be designed in an ideal environment, to the point of zero fuel consumption for heating and cooling with the aid of microcomputer programmes for thermal analysis.

The study makes use of the thermal calculations and concludes to comparative assessment of results and design recommendations for new houses for the Mediterranean region.

INTRODUCTION

The Mediterranean climate, although mostly mild, requires both the heating and cooling of buildings to varying degrees. The requirements for cooling are often predominant.

Rapid urbanization and the inefficient use of building services technology has had catastrophic consequences on many Mediterranean countries' ecology, culture and tradition. In domestic buildings there is a trend towards greater standards of comfort which has led to the increasing adoption of air conditioning systems. The successful implementation of energy conservation policies indicate that there is a considerable potential for energy savings in houses by employing appropriate architectural bioclimatic design strategies and improving the common building construction.

BACKGROUND ANALYSIS

An analysis of the energy situation in Cyprus to investigate the potential for energy saving in houses and the possible environmental improvement is carried out.

For this, existing and newly built houses are evaluated to identify deficiencies in the regulatory systems inherent in the built form that result in heating and cooling demands.

BIOCLIMATIC ANALYSIS

The prevailing climatic conditions in Cyprus are analysed, to assess how energy demands for heating and cooling arise in domestic buildings and to evaluate the free energy systems available to contribute to these requirements.

Also standards of comfort for single family detached houses in Cyprus are established, through investigation of current thermostat settings and reviews of thermal comfort studies, so they may be taken as a basis in the optimization study.

HOUSE DESCRIPTION AND SIMULATIONS

This section deals with the description of a specific house type and the optimization of the house, to be designed in an ideal environment, to the point of zero fuel consumption for heating and cooling with the aid of microcomputer programmes for ther-

mal analysis. Initially simplified thermal calculations are carried out by using "Method 5000", a well established method adopted by the Commission of the European Communities Handbook. These are followed by detailed hourly simulations of selected variants using dynamic simulation model "SERIRES". Finally thermal analysis programme "QUICK" is used to study the effect of occupants' interaction with the building.

RESULTS ANALYSIS

This section also makes use of thermal calculations and concludes to comparative assessment of results, and design recommendations for new houses through economic analysis of the varied design measures.

The results are discussed classified in four major variables:

1. Shape
2. Mass
3. Fenestration
4. Insulation

The effect of the most important parameters of these variables, on the thermal response of the building is assessed during both heating and cooling modes. The performance of the parameters is analysed, their efficiency is compared with each other and illustrated on tables and graphs.

1. Shape

The shape is examined in four main variations:

Rectangular

L-Shape

Π-Shape

Square

The following aspects are considered in combination with the varied shape designs:

(a) Shape - Variations

(b) Fenestration - Maximizing South and minimizing North glazing area

(c) Mass - Addition of mass Internally and Externally

(d) Insulation- Introduction of insulation

Conclusive Remarks on Shape

(a) Shape: The results indicate that simple compact shapes are more energy efficient than complex ones. However variation or introduction of other parameters on complex shapes might render them more energy efficient.

(b) Shape and Fenestration: Maximizing glazing on south side increases cooling load on all shapes; adding up, however the savings incurring from solar gains in winter reduces the total energy load.

(c) Shape and Mass: Regarding mass, addition of it externally increases heating and cooling load on all shapes, where as addition of internal mass decreases both.

(d) Insulation: The introduction of insulation on the more complex shapes renders them more energy efficient than simpler ones. As for example addition of it on Π-shape upgrades it as the most economical from all other shapes.

Summing up, it is concluded that the development of the building variables, in various shapes, into a dynamic pattern of design choices and constraints necessitates thermal studies for each single building with its own geometry, configurations and particularities.

2. Mass

The aspects relating to mass are of particular significance for Cyprus due to the large diurnal fluctuations (15 to 25 degrees centigrade), and the potential possessed by mass for large solar contribution in winter and cooling in summer.

The addition of internal mass is very effective in utilizing winter solar gains and the coolness of the summer nights. However, addition of external mass increases energy consumption. This is attributed to the con-

cept of the addition of mass which is introduced as the replacement of the brickwalls, by concrete walls; Whereas masonry provides good heat storage medium within a space, it readily passes this heat to the outside when added on exterior walls.

From the studies it also appears that the extend of mass increase seems to be critical concerning its effect on the energy loading.

3. Fenestration

Within the range of tests regarding fenestration design the thermal response of the building is examined in relation to:

(a) Orientation and glazing area

(i) Uniform distribution of glazing on all sides.

(ii) Re-orientation of glazing maximizing south window area.

(b) Shading

(i) Introduction of shutters

(ii) Addition of overhangs and vertical side-fins.

(c) Infiltration Rate and Ventilation

(i) Controlled infiltration in winter (0.5 ac/h).

(ii) Increased ventilation in summer nights (15 ac/h).

(d) Glazing Type

(i) Single glazing in all windows

(ii) Double glazing in all windows

(iii) Double glazing on north windows

Conclusive Remarks on Fenestration

It is concluded that fenestration is thermally a very sensitive, complex, many sided parameter which should be examined in conjuction to the entire building design. Main observations are:

(a) Orientation: Avoiding east and west fenestration eliminates the potential of useful morning and afternoon solar gains which are desirable and beneficial for the thermal performance of the building. However summing up the cooling savings resulting from the reduction of overheating from east and west, in summer, the yearly energy consumption is reduced.

(b) Shading: Regardless orientation, permanent overhangs and sidefins limit useful solar gains in winter; however they reduce considerably the cooling load in the summer. Movable shading devices offer flexibility and intrinsically have the potential for controlled operation.

(c) Ventilation and Infiltration Rate: Controlling air infiltration rate, limits thermal losses in winter and heat gains in summer. This, combined with increased summer night ventilation, constitutes an effective measure in minimizing air conditioning energy load.

(d) Glazing Type: Double glazing reduces heat losses in winter and consequently the total energy load. However the cost effectiveness of double glazing depends upon many other parameters of fenestration.

4. Insulation

The insulation application on the reference design, although involving some extra cost, is a simple, straight forward measure in reducing the energy load in the building without any further design implication; this is an attractive non-restrictive design option easily accepted and adopted by the designers as well as the owners. Its comparison with other passive design measures entailing no additional or little cost gives an indication of the cost effectiveness of the insulation.

In the building simulations the variable of insulation is examined in relation to the following parameters:

(a) Shape of Building

Introduction of insulation on the four selected basic shapes:

(i) Rectangular

(ii) L-Shape

(iii) Π-Shape

(iv) Square shape

(b) Thickness of Insulation

(i) Introduction of insulation 25 mm (Polystyrene)

(ii) Doubling insulation thickness to 50 mm

(iv) Trippling it to 75 mm

(c) Stage of introduction of the Insulation

(i) On reference house (Base-case)

(ii) On improved house design

(iii) On optimized house (nearing zero energy house)

(d) The Position of Insulation on the Envelope

(i) Internally

(ii) Sandwiched

(iii) Externally

(e) Extend of Insulation Application

(i) On roof only

(ii) On roof and walls

(iv) On roof, walls and floors

Conclusive Remarks on Insulation

Conclusions on insulation in conjuction with other parameters are summarized as follows:

(a) Shape: The addition of insulation acts as a regulator of energy conservation on a geometrically complex building shape. This is at an additional cost and therefore the economic assessment of insulation should be viewed in each shape variation of building.

(b) Thickness: Energy consumption savings do not increase proportionally to the thickness increase. On the contrary there appears reduction of savings.

(c) Stage of Introduction: Comparison of insulation application on reference and improved design is most effective. It seems that the combination of other design measures increases the effectiveness of insulation.

(d) Position of Insulation: The positioning of insulation externally is derived as the most effective for the climatological conditions of Mediterranean region.

(e) Extend of Insulation Application: The roof is thermally the most vulnerable building component of the Cypriot house; therefore the application of insulation on the roof is the most cost effective energy saving design measure. Extending insulation on the walls reduces the energy load but at an additional cost, whereas extending it on the floor the energy load increases.

ZERO ENERGY HOUSE

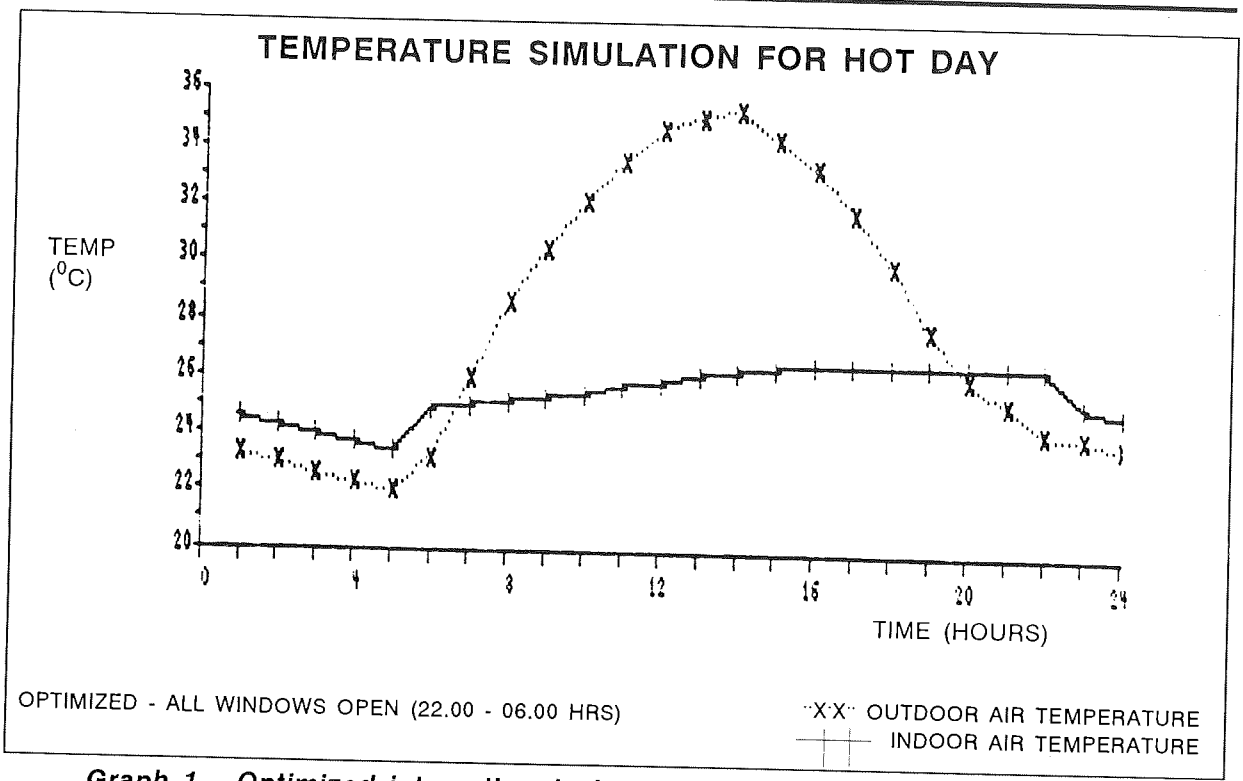
From the study it was found that "Zero Energy House" can be achieved by many different combinations of effective variables such as compact shape and the optimization of insulation, internal mass and fenestration design. A change of one can frequently be compensated for by changes in the others. This presents no difficulty in achieving if the users' constraints are all cast aside.

However, a house is not merely a container in which people act like robots and are placed to receive its thermal effects. There is a dynamic dialogue between building controls and building use. Furthermore, for the Mediterranean climate, it is necessary that some of the employed passive systems for the optimization must be activated by the users in order to be effective (Graph 1 and 3).

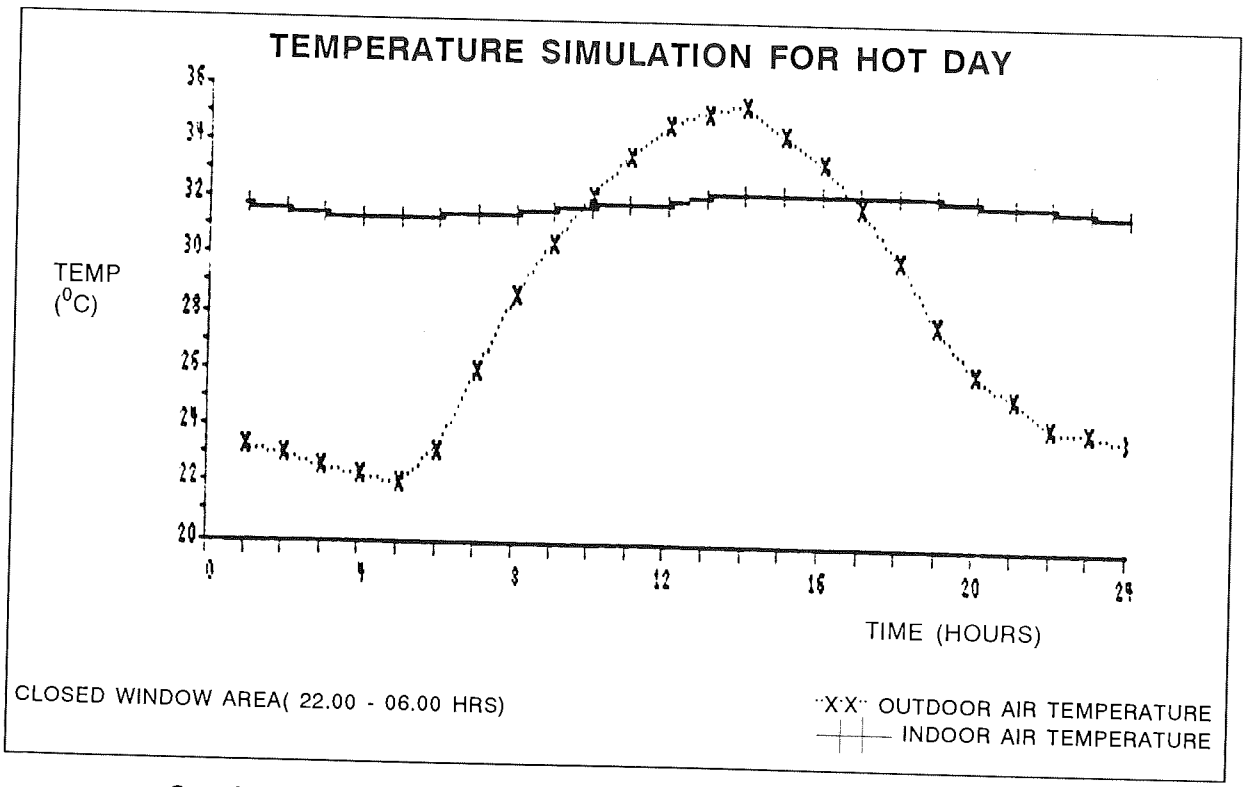
From the analysis of the results, it was found that the variable of fenestration houses the user interactive parameters which could be critical for the optimal performance of the "Zero Energy House" such as:

(i) Use of shutters for shading

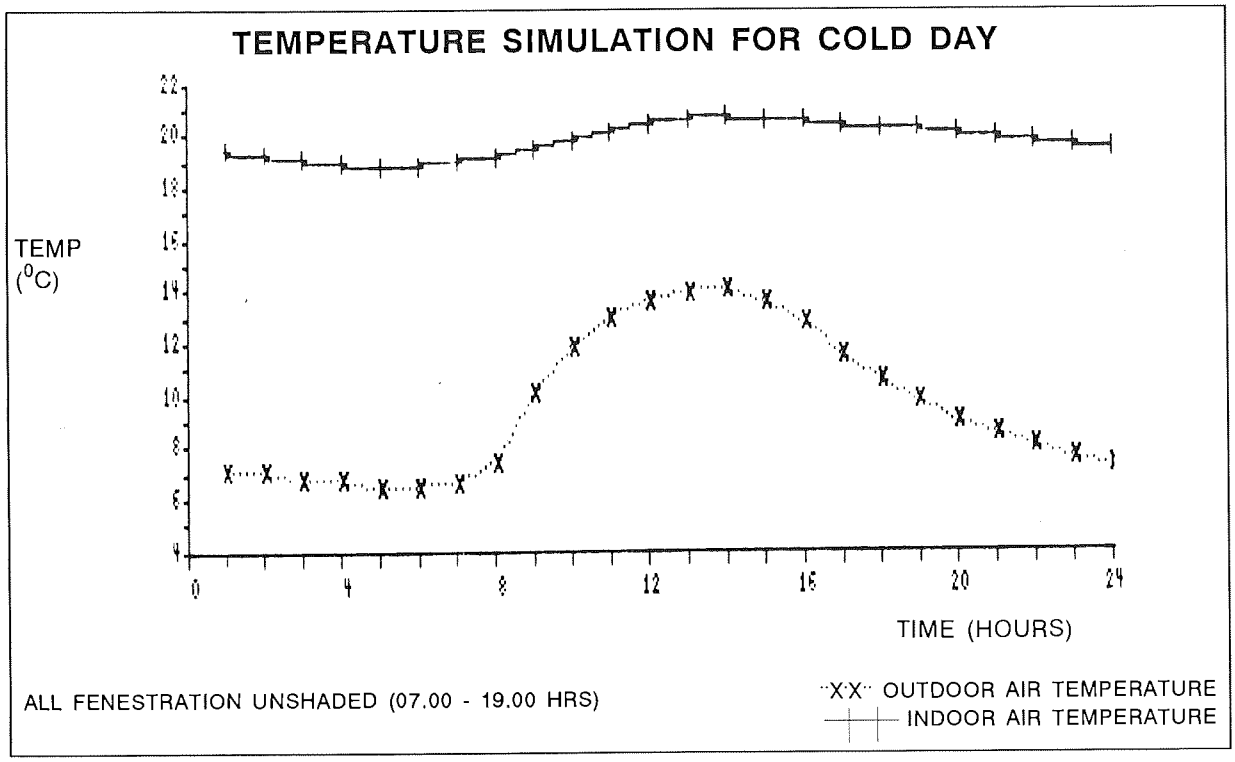
(ii) Opening and closing windows



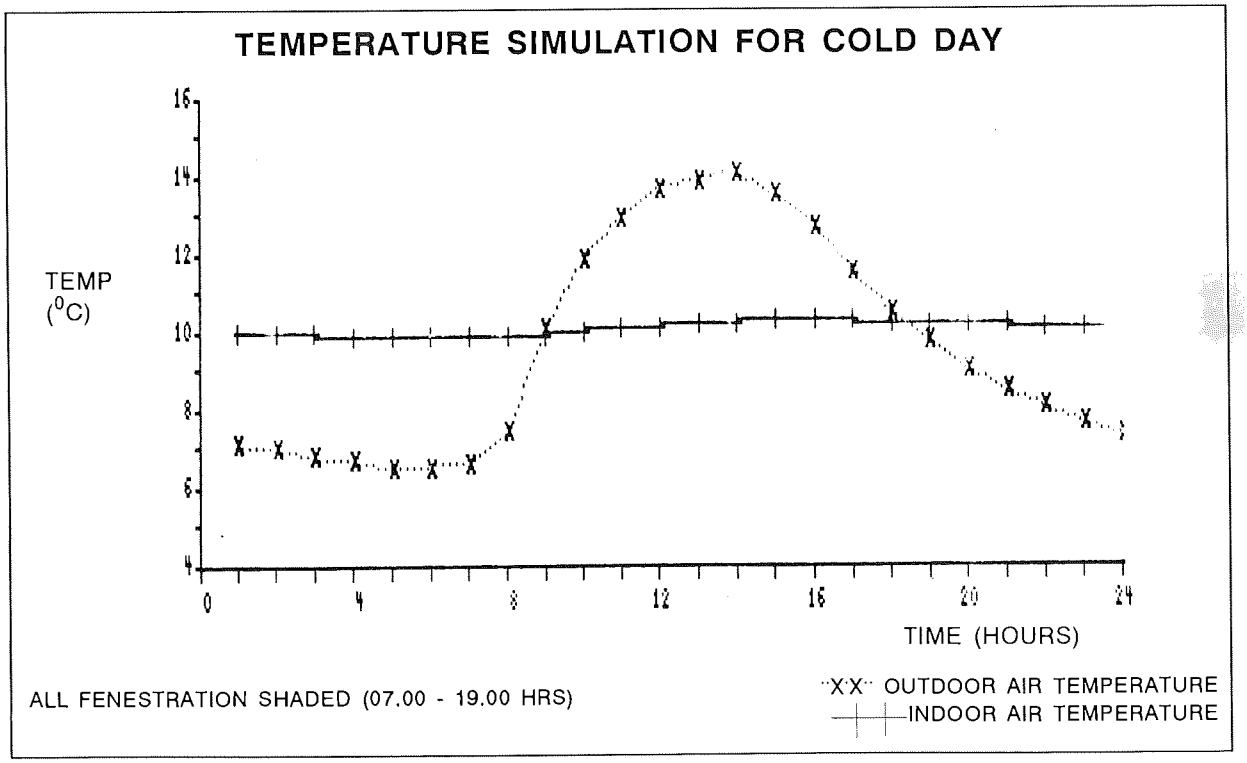
Graph 1 Optimized interactive design for indoor comfort in the summer without mechanical cooling



Graph 2 Counter effect of misusing windows in the summer. Indoor temperature raised above outdoor.



Graph 3 Optimized interactive design for indoor comfort in winter without mechanical heating



Graph 4 Counter effect of misusing windows in winter. Indoor temperature drops below outdoor.

The relative thermal effects of these parameters in various combinations in computer simulations, are considered. The observations converge on the conclusion that the counter-effect of misusing windows in either season might defeat the optimized performance of the "Zero Energy House" to the extend of dropping indoor temperature below outdoor during winter or raising it above outdoor in the summer (Graphs 2 and 4).

Furthermore the results imply the significance of well aware, well informed, cautious end-users. However, the introduction of automatic shading and ventilating controls could eliminate the negative effects of the manually operated windows. This may lead to the optimal choice between different design alternatives based on flexibility, operational ease, potential thermal efficiency and cost-effectiveness, and by reducing the operational constraints currently imposed upon buildings, will secure an optimized performance for "Zero Energy" houses.

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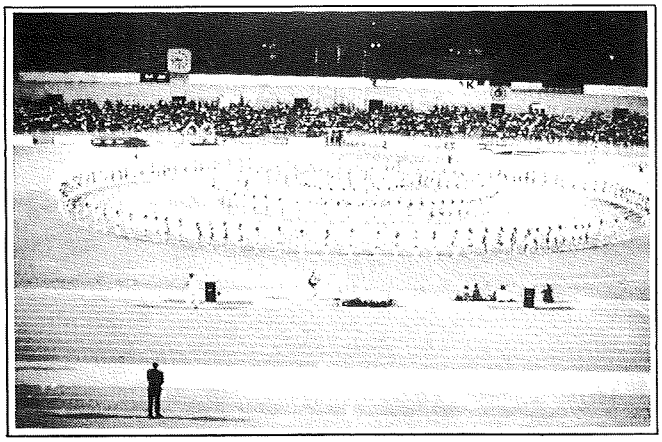
Computerized Information System for the ISF World Gymnasiade1994

Christos Makarounas , BSc
Lecturer, HTI

Cyprus undertook to host the International School Federation (ISF) World Gymnasiade 1994. The major concern and responsibility of the ISF is education in and through sport. The Gymnasiade is an event which brings together the whole family of the ISF. It includes individual competitions in athletics, swimming, gymnastics and modern rhythmic gymnastics.



The Cyprus organising committee gave priority to how information would be processed and presented to officials, coaches, mass media and the public. For this reason a computerized information system has been developed for easy, fast, accurate and efficient access, manipulation and presentation of all information related to the Games.

The analysis, design, development and installation of the whole information system was undertaken and carried out by the Higher Technical Institute. The project team consisted of two computer lecturers, five third year computer students and an electronics lecturer who was responsible for the on-line communication networks and the task of testing and maintaining the MODEMS and the hardware for the Games.

Another six members of the staff and 80 computer students acted as supervisors, operators, and report distributors. The system was designed to work around a Novell Network. A monochrome PC was connected via a 115 KBaud MNP 4&5 Modems to an assigned PC in the network at Higher Technical Institute, where the server was located. The communication software used enabled the system to run locally at Higher Technical Institute and only screens and printouts were sent to remote PCs, thus ensuring fast processing in a real network environment.

The system operated in a friendly environment, providing the user with extra features for security and presentability. Four levels of passwords were provided in order to protect the system from unauthorized access. The on-line help was an extra feature to give further explanation and assistance to the users. The system offered many useful utilities such as Backup and Restore which were easy to use.

The Gymnasiade 1994 computerized system is a complete system supported by a powerful database which handles a wide spectrum of information about the countries, athletes, the events, calendar, the place and time of events taking place as well as the results. Moreover, a user can acquire useful reports, statistical analysis of the results, and graphical representation of the medals.

HTI Calendar of Activities for Academic Year 1993-1994

D. Charalambidou-Solomi, BA, MA (Lit), MA (Ed)
Lecturer, HTI

SEPTEMBER

- Two hundred and thirty-nine (239) new students were enrolled on the regular courses of HTI: 63 for Electrical Engineering, 60 for Civil Engineering, 59 for Mechanical Engineering, 25 for Marine Engineering and 32 for Computer Studies.

- Mr S. Kalogirou, Instructor, participated in the First International Enviromental Engineering Conference which was held between 12-23 September in Leicester, UK and presented a paper on "Solar Desalination: the Solution to Cyprus Water Shortage Problem".

OCTOBER

- Ms Maria Tsinda - Hadjiyiannakou, Lecturer, attended a course on "Software Engineering Technology and Management" under the Commonwealth Industrial Training and Experience Programe at National Centre for Software Technology (NCST), Bangalore, India between 4 October - 10 December.

- Mr Ch. Tsioutis, Instructor, attended a 60-hr course on "Computer Programming of Industrial Lathe and Milling Machines" organised by the Cyprus Productivity Centre between 5 October - 21 December.

- Mr I. Angeli, Laboratory Assistant, held an 8-hr seminar on "Total Quality Management (TQM)" on 7 October for the Industrial Training Authority employees.

- Mr I. Antoniou, and Mr St. Kyzas, Instructors, attended a 36-hr course on "Autocad" organised by the Cyprus Productivity Centre between 11 October - 17 November.

- Mr D. Andreou, Lecturer, visited the Glamorgan University in Wales between 25 October - 5 November on a staff exchange programme between HTI and the Glamorgan University.

- Dr Chr. Chrysostomou, Lecturer, visited the City University in London between 25 October - 5 November on a staff exchange programme between HTI and the City University.

- Dr D. Serghides, Senior Lecturer, was re-elected president of the ISES - Cyprus in the General Assembly held on 31 October.

NOVEMBER

- The First Mid-Semester Examinations were held between 1-5 November.

- HTI in collaboration with IEE Cyprus Centre and the Industrial Training Authority organised a 20-hr course on "Troubleshooting Novell Netware" which was developed by the Euromanagement and Technology Bureau, London, and aimed at engineers working in industry. The course was delivered by Mr Alan Freeman between 1-3 November and was attended by 20 participants.

- HTI in collaboration with the Cyprus Computer Society organised a course on "Introduction to C^{++} Programming and Object Oriented Design" between 1-4 November which was aimed at computer professionals working in the private and semi-government sectors.

- Mr S. Savvides, Workshop Superintendent, visited the University of Glamorgan between 1-5 November under the staff exchange educational scheme between HTI and the Glamorgan University.

- HTI in collaboration with the Cyprus Computer Society organised a course on "Evaluation and Implementing Local Area Networks" financed by the Industrial Training Authority between 15-16 November which was aimed at computer professionals working in the private and semi-government sectors.

- HTI in collaboration with IEE Cyprus Centre and the Industrial Training Authority organised a 20-hr course on "Object Oriented C^{++}" between 15-17 November. The course was developed by the Euromanagement and

Technology Bureau, London, and was presented by their authorised instructor Ms Carol Weaver and was attended by 11 participants.

- The HTI Administration Team in its meeting of 16 November decided that the sum of £2.00 is collected from each member of HTI staff in order to cover part of the funeral cost of Constantinos Konnaris, ex-President of HTI Students Union, who had passed away; the full cost of his funeral was paid by the HTI Students Union.

- HTI in collaboration with the Cyprus Computer Society organised a course on "Interworking: TCP/IP Concepts and Developments" financed by the Industrial Training Aurhority between 17-18 November which was tailored for computer professionals.

- The HTI UNESCO Day was celebrated on Thursday, 18 November. Students and staff visited the ancient Amathus archaeological site in Limassol. The archaeologist, Ms E. Procopiou, from the Department of Antiquities outlined the history of the ancient city of Amathus. The visit ended with lunch at Santa Barbara restaurant.

- HTI in collaboration with the Cyprus Computer Society organised a course on "Open Systems" financed by the Industrial Training Authority between 29 November - 1 December which was aimed at computer professionals.

DECEMBER

- HTI in collaboration with the Cyprus Computer Society organised a course on "Internetworking: Bridges / Routers / Gateways" financed by the Industrial Training Authority between 2-4 December for computer professionals.

- The HTI Students Union organised a Christmas party on Wednesday 22 December in the Students Canteen.

- Lectures stopped on 24 December for the annual two-week Christmas break.

JANUARY

- The Annual General Conference of the International Association for the Exchange of Students for Technical Experience (IAESTE) was held in Mexico City between 15-21 January and fifty-five countries participated.
- HTI was represented by the HTI Director, Mr D. Lazarides, Chairman, and Mr. Ch. Chrysafiades, National Secretary of IAESTE - Cyprus.
- The Cyprus delegation secured 34 places for the summer training of HTI students and offered 31 places to students from various IAESTE member countries to receive training in Cyprus.

- Mr I. Angeli, Laboratory Assistant, gave a lecture on "Research on the Evaluation of the Status of Total Quality Management (TQM) for Cyprus Manufacturing Industry" on Monday, 31 January in the HTI Amphitheatre.

- The HTI Workshops organised a course on First Aid which started in January and was completed in April and was attended by 23 participants. The course was presented by HTI Instructors Mr M. Shiammas, Mr Ch. Tsioutis, Mr C. Christofi and Mr St. Kyzas. The successful participants were awarded the First Aid Certificate of St. John Ambulance.

- The First Semester Examinations were held between 17 January - 28 January.

- Classes and Industrial Training commenced on 31 January.

FEBRUARY

- The Lecturers I. Economides, D. Andreou and A. Kkolos supervised laboratory sessions on structures and surveying for the Civil Engineering Instructors of the Technical Schools. The laboratory sessions were held every Wednesday afternoon for 3 hrs between February and May.

- The HTI Department of Mechanical and Marine Engineering offered an 18-hr course on "Statistical Process Control" which was aimed at HTI personnel.

MARCH

- HTI organised a Carnival Dance on Thursday 10 March at the Pavilion Restaurant which was a great success.

- Mr I. Angeli, Laboratory Assistant, was elected Chartered Mechanical Engineer on 16 March.

• Mr G. Iordanou, Head of Mechanical Engineering Department, and Mr M. Pattichis, Senior Lecturer, visited China as guests of the China State Science and Technology Commission between 18-30 March within the framework of implementing the Cyprus - China Protocol of the Third Synod Intergovernmental Committee.

• HTI in co-operation with the Euromanagement & Technology Bureau, organised a course on "Supporting, Maintaining & Troubleshooting PCs" between 28-31 March. The 30-hr course, which was aimed at personnel working in industry, was presented by Mr Neal Hutchinson and was attended by 24 participants.

• The Second Mid-Semester Examinations were held between 28 March - 6 April.

APRIL

• Dr D. Serghides, Senior Lecturer, visited China as a guest of the China Science & Technology Commission between 1-15 April within the framework of implementing the Cyprus - China Protocol of the Third Synod Intergovernmental Committee.

• HTI in co-operation with the Cyprus Computer Society organised a course on "Introduction to Fiber Optics Communication" between 5-8 April. The course was financed by the Industrial Training Authority and was aimed at professionals in the private and semi - government sectors.

• Mr I. Angeli, Laboratory Assistant, organised and delivered an 18-hr course on "Statistical Process Control (SPC)" which was attended by HTI second and third near Mechanical Engineering students and members of the academic staff.

• The HTI Social Formal Dinner of the third year students was held on Thursday 7 April at the Ledra Hotel.

• On 16 April Dr Chr. Papaleontiou, Lecturer, participated in a meeting between Greek Cypriot and Turkish Cypriot profesionals the purpose of which was the exchange of professional information on earthquakes, building materials and restoration of structures. The meeting was the result of the initiative of the Cyprus Association of Civil Engineers and Architects with the co-operation of the Turkish Cypriot respective Association.

• HTI in co-operation with the Cyprus Computer Society organised a course on "Introduction to Client/Server Computing" between 19-22 April. The course was financed by the Industrial Training Authority and was attended by professionals from the private and semi-government sectors.

• Mr G. Alexandrou, Instructor, attended a 50-hr course on "Technical drawing and cost estimating for furniture and carpentry works" organised by the Cyprus Productivity Centre between 20 April - 22 June.

• Mr I. Angeli, Laboratory Assistant, delivered an open lecture to IEE Cyprus members on "The Importance of Quality Management" at the Cyprus Popular Bank Cultural Centre in Nicosia on 20 April.

• HTI organised a Blood Donation Day to celebrate the 25th anniversary of its establishment on Thursday 21 April on its premises. It was attended by the Minister of Labour and Social Insurance, Mr A. Moushouttas, the Minister of Health, Mr M. Christophides, and the Director General of the Ministry of Labour and Social Insurance, Mr G. Anastasiades. Certificates were awarded to staff blood donors.

• Dr Chr. Papaleontiou, Lecturer, participated in a workshop on Seimology of the Eastern Mediterranean and the Middle East which was organised by USA and the United Nations between 25-29 April and was attended by seismologists from ten countries.

MAY

• On Tuesday, 17 May, HTI organised an Open Day to mark the 25th anniversary of its establishment. Representatives from Industry and Secondary School Students visited HTI premises and were guided by HTI personnel to HTI Laboratories and Workshops.

• Mr I. Angeli, Laboratory Assistant, participated in a 2-day course on "Quality Function Deployment" organised by ROM Technologies in Tel-Aviv, Israel between 25-26 May.

• On Thursday, 26 May, HTI organised a one-day Cultural Festival at the SKALI open

theatre of Aglanja as part of the activities organised to mark the 25th anniversary of its establishment. The programme of the Festival included award of prizes to all winning athletic teams, a one-act play, music, singing and traditional dances by the Greek group Markides Pouliou from Kozani.

• On 30 May a two-member delegation from China visisted HTI for discussions on science and technology issues within the framework of implementing the Cyprus-China Protocol of the Third Synod Integovernmental Committee.

• HTI in collaboration with IEE-Cyprus Centre and the Industrial Training Authority organised a course on "Designing and Installing LANS" between 31 May - 3 June. The course was presented by an authorised instructor of the Euromanagement & Technology Bureay, London, and was attended by 20 participants.

• Second Semester Examinations began 30 May and ended 10 June.

JUNE

• On Friday, 3 June, a Dinner was held at Paraschos Tavern to formally bid farewell to two members of staff who retired recently: Mr St. Anastasiou, Head of the Electrical Department, and Mr A. Kaplanis, Senior Lecturer of the same Department and ex-chief Editor of "HTI Review".

• HTI in collaboration with IEE-Cyprus Centre and the Industrial Training Authority organised a course on "Interconnecting Unix, 05/2 and Netware" between 6-8 June. The course was presented by an authorised instructor of the Euromanagement & Technology Bureau, London, and was attended by 25 participants.

• HTI in co-operation with the Cyprus Computer Society organised a course on "Software Project Planning and Management" between 7-10 June. The course was financed by the Industrial Training Authority and was attended by professionals from the private and semi-government sectors.

• HTI in collaboration with the Cyprus Professional Engineers Association and the Industrial Training Authority organised a course on "Engineers' Guide to Financial Accounting" between 13-15 June. This course was presented by an authorised instructor of Ioannou & Zampellas - Coopers & Lybrand - Cyprus and was attended by 21 participants.

• Dr P. Eleftheriou, Lecturer, with two researchers from the Russian Institute of Physics, Dr Grouber and Dr Ponomarev announced on Monday 27 June, some of the research results of the project "Atmospheric Pollution of Eastern Mediterranean" which is part of a major E.U. project (AVICENNE group) in which HTI participates in collaboration with the Aristotelian University of Salonika and the University of Ben Gurion of Israel.

• HTI in co-operation with the Cyprus Computer Society organised a course on "Internetworking TCP/IP Concepts and Developments" which was financed by the Industrial Training Authority and attended by professionals from the private and semi-government sectors between 27-28 June.

• HTI in co-operation with the Cyprus Computer Society organised a course on "Computer Networks Security" between 29-30 • June which was financed by the Industrial Training Authority and attended by professionals from the private and semi-government sectors.

JULY

• On Friday, 8 July, a seminar was held in the HTI Amphitheatre on "Assessment - Objectives and Interpretation of Results" led by Dr Lawrence Kavich, Professor of Education at the University of Northern Iowa, USA, in his capacity as a Fulbright visiting professor.

• The HTI Graduation Ceremony was held on Friday, 1 July, at the Cyprus International Conference Centre. H.E. the President of the Republic, Mr Glafcos Clerides, attended the Ceremony and awarded the Presidential Prize for the Highest Overall Performance. The HTI Director, Mr D. Lazarides, delivered the Graduation Speech and awarded all other prizes. The gathering was also addressed by the President of the Students Union, Mr Andreas Kyriakides. The Hon. Minister of Labour and Social Insurance, Mr Andreas Moushouttas, awarded the diplomas to the graduates of the Civil, Electrical, Mechanical, Marine and Computer Studies specialisations.

Cyprus an offshore centre

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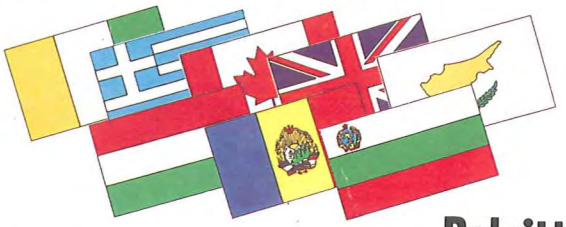

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ΔΙΚΟ ΣΑΣ ΣΠΙΤΙ

από το όνειρο... στην πραγματικότητα

Η ΕΤΑΙΡΕΙΑ ΠΟΥ ΠΡΟΣΦΕΡΕΙ ΣΤΑ ΜΕΛΗ ΤΗΣ ΟΥΣΙΑΣΤΙΚΗ ΕΞΥΠΗΡΕΤΗΣΗ

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4. Δεχόμαστε καταθέσεις όλων των τύπων από μέλη και μη μέλη με πολύ ΕΥΝΟΙΚΟΥΣ ΟΡΟΥΣ.

5. Για καλύτερη εξυπηρέτηση των μελών άρχισε η λειτουργία του θεσμού των τρεχούμενων λογαριασμών.

ΣΥΝΕΡΓΑΤΙΚΗ ΟΙΚΟΔΟΜΙΚΗ ΕΤΑΙΡΕΙΑ ΔΗΜΟΣΙΩΝ ΥΠΑΛΛΗΛΩΝ ΚΥΠΡΟΥ ΛΤΔ

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