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UNESCO MISSION TO ISTANBUL
NOVEMBER 1993

TO REPORT ON THE PRESENT STATE OF THE HAGIA SOPHIA MONUMENT
AND MAKE RECOMMENDATIONS FOR ITS PRESERVATION AND RESTORATION

MISSION REPORT

prepared by R J Mainstone
on behalf of the members of the mission

18 April 1994
revised 9 December 1994

FOREWORD

This report has as its origin a query addressed to the Director-General in 1993 about the state of what is now the museum of Aya Sofya in Istanbul. Orginally Hagia Sophia, the principal church of the Byzantine Empire and subsequently the Ottoman mosque of Aya Sofya, this historic building is also known as Saint Sophia.

At the invitation of the Turkish authorities a mission comprising high-level experts from Belgium, Greece and the United Kingdom visited Istanbul in November 1993. It had as its terms of reference to assess the present state of the building and to make recommendations to the Turkish authorities on ways to ensure its continued safeguarding.

In view of the limited time available, it was decided to draft the report of the mission after the departure from Istanbul of its members, one of whom, Dr. Rowland Mainstone, whose involvement with Saint Sophia began in 1958, kindly agreed to undertake the task. Further consultations with Turkish colleagues proved necessary before the report could be finalized.

The excellent collaboration of the Turkish experts and officials throughout this process should be emphasized.

1 THE MISSION

The mission took place between 14 and 21 November 1993 for the purpose of assessing the present state of the Hagia Sophia (Aya Sofya) monument in Istanbul and making recommendations for its preservation and restoration.

The members were:

Professor Dr R Lemaire (University of Leuven, also Honorary President of ICOMOS)

Dr R J Mainstone (formerly UK Building Research Establishment and Professor, University of Leeds and University College, London)

Professor Dr C Mango (University of Oxford and formerly Kings College, London and Dumbarton Oaks, Harvard University)

Professor Dr T P Tassios (National Technical University, Athens)

accompanied by Said Zulficar (Division of Cultural Heritage, UNESCO)

We were received on 15 November by Ms Ülkü Izmirligil, Dipl. Architect and Archaeologist (Director of the Central Laboratory for Restoration and Conservation) who with Nevzat Özinanç, Dipl Engineer (controller of restoration works on Hagia Sophia) outlined present responsibilities for historic monuments in Turkey as these affected Hagia Sophia and assisted us greatly by arranging meetings with the following:

Representatives of the Net Construction Company (Net Yapi) currently working in Hagia Sophia under contract to the Ministry of Culture

Professor Müfit Yorulmaz (Technical University of Istanbul, joint director with Assistant Professor Kenichiro Hidaka of the University of Tsukaba, Japan, of a structural research project on Hagia Sophia and consultant to the Ministry of Culture on Hagia Sophia restoration)

Professor Dr Mustafa Erdik (Department of Earthquake Engineering, Bogazici University, joint director with Professor Dr Ahmet Çakmak of Princeton University, USA, of another structural research project on Hagia Sophia and consultant to the Ministry of Culture on Hagia Sophia restoration)

Peter Berzobohaty and Tom Organ (mosaic conservators currently working in Hagia Sophia under contract to the Ministry of Culture with the support of UNESCO World Heritage Fund and in association with Turkish experts headed by Revza Ozil, Dipl. Conservation and Archaeologist, from the Central Laboratory for Restoration and Conservation)

Professor Nevzat Ilhan (Yildiz Technical University, also member of the Turkish National ICOMOS Committee)

Professor Dr Engin Özgen (Director General of Monuments and Museums, Ministry of Culture)

Dr Ahmet Güleç (Chemist, Central Laboratory for Conservation and Restoration)

Erdem Yucel (Director of the Hagia Sophia Museum)

It was unfortunately not possible to meet Professor Dr Zeynep Ahunbay (Technical University of Istanbul and also a consultant to the Ministry of Culture on Hagia Sophia restoration) who was abroad at the time.

During the meetings we were given a further insight into the present arrangements for general oversight of the monument and into action now being taken for its conservation and restoration. We also learnt something of current research relevant to the latter and were able to examine closely the present state of the dome mosaics.

There was less opportunity for inspection of the structural condition of the fabric and no time was available to discuss it before one member departed on 19 November. What follows on this topic has therefore had to be based partly on prior knowledge and (in the absence of a further meeting) on subsequent exchanges of ideas by correspondence.

At the end of the mission, Assistant Professor Uğur Tanyeli of Anadolu University with Dr Gülsün Tanyeli of the Technical University of Istanbul and Prof Dr Afife Bahur of the Technical University of Istanbul were invited to speak about their recent researches on the iron reinforcements of Hagia Sophia and damage caused to the historic buildings of Istanbul by the 1894 earthquake.

Some additional information, chiefly on matters of organisation and responsibilities, was forwarded by Ms Izmirligil towards the end of October 1994. On this basis certain revisions have been made in this final version of the report. Notes have been added at its end about actions taken since the mission about which we were similarly informed.

2 HAGIA SOPHIA

Hagia Sophia, though now a museum, was the unchallenged principal church of the Byzantine Empire for over 9 centuries and the principal Ottoman mosque for almost 5 centuries more. It was also one of the greatest architectural achievements of all time and no other has been as influential. It remains one of the focal points of what is now rightly designated as the World Heritage site of the historic quarters of the old city of Istanbul and attracts vast numbers of visitors throughout the year.

To anyone sensitive to spatial character, the vast interior with its ever elusive and endlessly intriguing boundaries continues to amaze. But much has been lost of its original splendour of light and colour. The 19th century painted decoration of most of the vaults is badly discoloured by damp even where recently renewed, there have been local falls of plaster, and the marble facings lower down are dirty, giving the monument a "tired" look. The exterior, though repainted somewhat inappropriately only a few years ago, is already similarly discoloured by uneven weathering. Inside again, there is widespread evidence of rising damp, of damp penetration through ill maintained lead roofing

and broken windows, and (in the early summer) of condensation. There are also conspicuous deformations and less conspicuous scars testifying to a somewhat fraught initial construction followed by a long history of earthquakes and intervening periods of neglect. The last known major structural intervention was in 1926.

It is therefore timely to consider, in the light of present knowledge and understanding and present ideas about conservation objectives and practice, what should now be done to safeguard the structure from the effects of future earthquakes, to conserve what has survived of the marble and mosaic of the interior and to give back some of the lost splendour.

3 PRESENT ARRANGEMENTS FOR OVERSIGHT, CONSERVATION AND RESTORATION

Within the General Directorate of Monuments and Museums in the Ministry of Culture, responsibility for the care of the monument is currently shared between the following three groups:

1) The Central Laboratory for Restoration and Conservation (Director Ms Ulku Izmirligil) is responsible for conservation of the mosaics.

2) The Directorate of Surveying and Monuments (Director Mr Muharrem Oral) is responsible for the supervision and coordination of works and for payments, with Nevzat Ozinanç as controller for Hagia Sophia.

3) The Directorate for Culture in Istanbul (within which Erdem Yucel is Director of the Aya Sofya Museum) is responsible for the operation of the monument as a museum but not for the monument itself.

Mindful, however, of the needs outlined above and with additional funds allocated by the Ministry, the General Directorate of Monuments and Museums has recently taken a number of further steps to meet them:

1) An outside contractor (Net Yapi) has been appointed with a wide brief to undertake necessary restoration works.

2) A Consultants' Committee (consisting of Professors Ahunbay, Erdik and Yorulmaz and subsequently joined by Professor Zerrin Yilmaz Aygün to advise on humidity and condensation problems) was established in 1992 to advise on desirable works and, where appropriate, to suggest actions for urgent repairs.

3) A larger Advisers' Committee was also established. On this committee, members of the Consultants' Committee are joined by representatives of the contractor and of all the responsible groups within the Ministry (Museum Directorate, Directorate of Surveying and Monuments, and Central Laboratory for Restoration and Conservation) to discuss problems that call for attention and to decide on the actions to be taken by the contractor under the supervision of Mr Özinanç.

What we see as a desirable simplification of this present pattern of responsibilities is referred to in section 10 after a discussion of the main conservation needs.

4 THE STRUCTURE: ASSESSMENTS AND DESIRABLE INVESTIGATIONS

The structure today

The structure was from the start a complex one and the complexity of both form and substance are now unparallelled as a result of changes during its long life (figs 1 and 2). Only four main materials were used - greenstone, marble, brick and a hydraulic mortar - with a supplementary use of timber and iron as struts and ties. But even during initial construction there were lacks of bond between adjacent elements, and there are now many more of these where later additions and infills and partial reconstructions were simply butted against the existing masonry.

As in all large masonry structures there is also extensive cracking, though most of this is now hidden behind surface stucco, mosaic or revetment. It has been shown (Mainstone 1988) that much of it with the associated deformation occurred during first construction, largely as a result of premature loading of the mortar due to excessive haste in the later stages. Subsequent cracking, though accentuated by earthquakes, was the typical response of a large masonry structure to differential settlements and to the strains arising from differential heating and cooling under steady self-weight load. Deterioration of the mortar through water penetration or rising damp may also have led to local losses of strength, though the only observed deterioration from this cause has been in surface renderings.

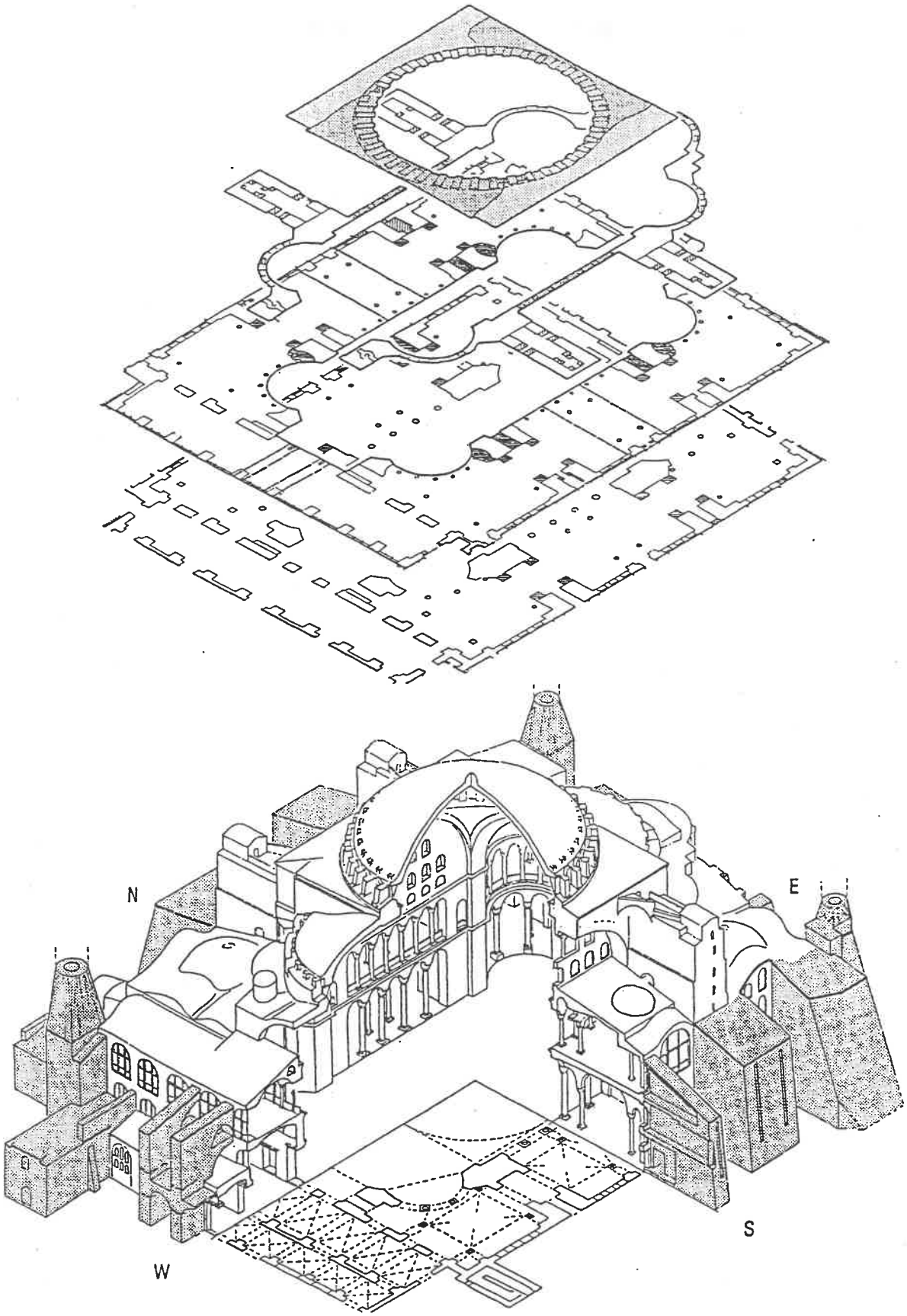
Assessment of present safety and possible strengthening measures

In spite of the cracking and deformation there has been no collapse affecting the main structure for more than 6 centuries. Even the earthquakes of 1766 and 1894 appear to have caused only minor damage and recent inspections by Mainstone (though restricted to parts of the structure to which access was possible in the limited times available) have shown no visible evidence of significant movements in the present century. Moreover, the structures that suffered the earlier partial collapses lacked most or all of the numerous infills, additional ties and massive buttressing on all sides added in later centuries (figs 1 and 2 again). For these and other reasons there seems to be no cause for immediate concern (Mainstone 1993).

The earlier collapses nevertheless warn against complacency.

Some recent and ongoing attempts to analyse by current numerical techniques the likely response to a future major earthquake were briefly outlined to us by Professors Erdik and Yorulmaz, and we are aware of similar studies at Princeton. There are, however, major difficulties in making such analyses of existing masonry structures. Existing cracks and vertical discontinuities cannot be ignored and, even for far less complex structures with less complex histories, there are too many unknowns.

The precise assumptions made in these analyses are not known, save that little or no account seems to have been taken of the cracks and dicontinuities or of existing high-level ties, and that most analytical models were highly simplified ones of part only of the structure - that



Figs 1 and 2 The structure today with partial reconstructions and main additions shown by hatching and stippling (Mainstone copyright)

part identified in Mainstone 1988 as the original 6th century primary structure (fig.3). If such analyses had been feasible when the structure was first designed they would then have had some relevance, but not now. Grave doubts arise therefore about the validity of the conclusions drawn. Presumably because some of the assumptions were different, the analyses have also led to different predictions of possible causes for concern and different suggested strengthening measures. It has been suggested on the basis of one analysis (Erdik 1993) that E-W reinforcement of the crown regions of the main E and W arches and the adjacent semidomes is desirable and on the basis of another (Swan and Çakmak 1993) that the need is for N-S prestressing of these same arch crowns. The necessary drilling for either of these suggested measures would introduce new hazards in critical regions and there is as yet no valid evidence that either would, on completion, be beneficial.[1]

Concerns were also expressed to us and proposals made by Net Yapi (Net Yapi 1993). We were impressed by their evident enthusiasm and goodwill and the pains they had taken to acquaint themselves with the building and to learn from relevant recent publications. But we saw no evidence of clearly formulated questions or objectives to guide their explorations. These seemed to have focussed rather randomly on secondary elements of the structure such as slopes in the north and south gallery floors and the leans of many of the monolithic columns that partly carry the domical vaults over the galleries. The leans are characteristic of the structure that has come down to us and to eliminate them (as Fossati did earlier for some exedrae columns) would alter its character, introduce new anomalies and further distort its historical witness.[1] Levelling of the floors would serve no useful purpose.[1] Nor would the renewal of the missing timbers that once spanned across the windows of the dome (and probably of the semidomes also). Indeed such works could easily do more harm than good.

In the course of inspections made during the mission, Lemaire and Tassios were chiefly concerned by the slightly damaged base of one gallery column which leaves a small fraction of its cross section unsupported. At both ground and gallery level Mainstone sees a more likely threat (if any) from further splitting of a column brought about by uneven bearing pressure at its head or foot and local internal weaknesses in the marble. All columns however were long ago tied circumferentially to counter this threat and they must have a large factor of safety on their full cross sections. Inconspicuous local making-good of the damaged base might be considered but would have to be done with great care to be effective. Further circumferential tying of some columns might also be considered. But neither should be attempted without full prior investigation.

If it is desired to increase the margin of safety against more serious collapse of the kind that has occurred previously, additional ties or consolidations of existing fills might be considered. But, before deciding upon <u>any</u> major intervention of this kind, we consider that <u>realistic</u> analyses of the <u>effects of the intervention</u> on the responses of the whole structure to a possible future strong earthquake are essential. To ensure that they are realistic they <u>must</u> be based on much more valid modelling of the structure than hitherto.

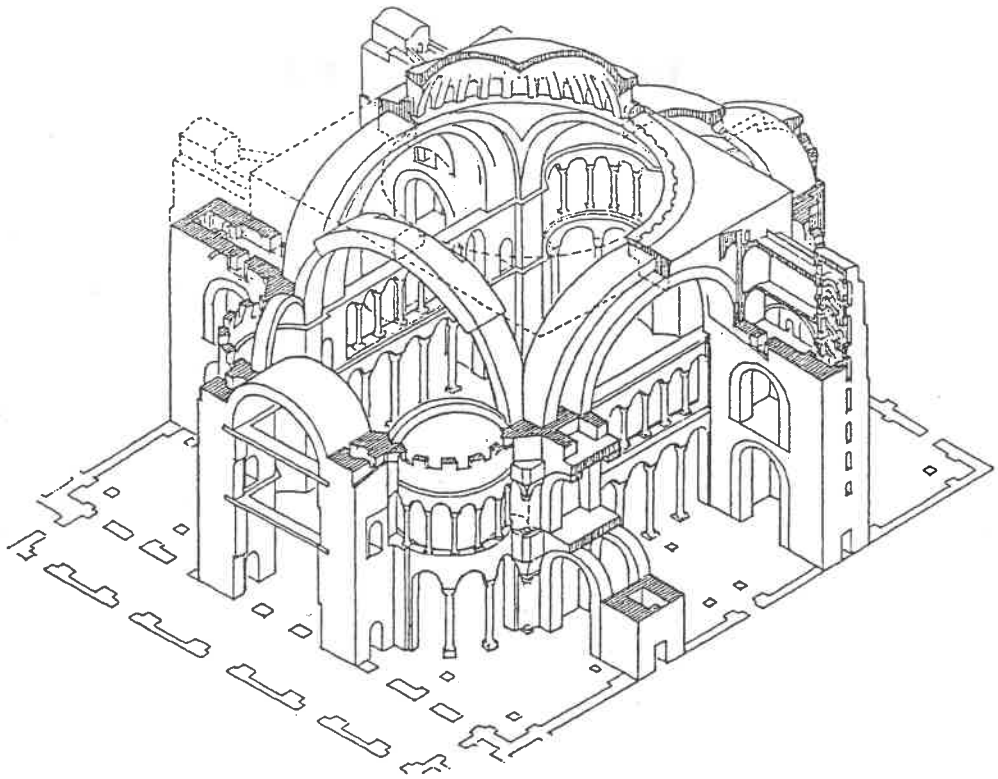


Fig.3 The original primary structure (Mainstone copyright)

As a basis for this modelling, the first need is for a distillation and critical appraisal of all that is now known about the structure, followed by the filling of significant gaps in knowledge so identified. Characteristics of the masonry (including probable zones of reduced strength), the bond or absence of bond between elements, hidden voids, and the extent and nature of cracking (including crack widths and other relative displacements) are all relevant. The modelling should also be guided by recorded patterns of response to actual earthquake shocks and, as an independent check on safety, there should be continuous monitoring of potentially dangerous long-term movements, both before, during and after any intervention. A second objective of the appraisal of current knowledge should be the precise specification of the most desirable monitoring.

Both the appraisal and the monitoring requirements are considered further in the following sections.

Distillation and appraisal of present knowledge of the structure

Fortunately there is an unprecedentedly complete and accurate record of all that it was possible to observe and measure during the period 1937-69. This takes the form partly of a vast archive at Dumbarton Oaks of field notes and unpublished drawings and partly of a published series of meticulously accurate plans, elevations and sections (Van Nice 1965 and 1986). These are the fruits of at least 50 man-years of skilled work. This record is supplemented and brought up to date by the observations of Mainstone from 1965 onwards, by photogrammetric surveys of the interiors of the dome and main semidomes (Gurkan et al.1992 and

Hidaka et al.1993), and by recent exploratory probes of the dome and investigations of foundation conditions in the nave. In addition Mainstone (1988 and elsewhere) has established most of the history of construction and subsequent change that is relevant to an assessment of the present state.

The limitations of these data, especially the published data, must however be recognised. For instance the published Van Nice plans, elevations and sections (1965 and 1986) show only what could be directly observed and measured (mostly on the surface) and only to the extent feasible on a limited number of sheets. There are therefore lacunae and ambiguities which are partly but not wholly filled by the field notes and unpublished drawings. Mainstone 1988 is a valuable complement but was not written as a structural appraisal of the building as it stands today. Nor was it intended to be used as it has been as a basis for analyses like those recently undertaken and referred to above. It was written primarily as an account of the design and construction of the original structure and, as such, it dealt with subsequent changes chiefly in order to discount them. It placed little stress on the unparallelled complexity of the present structure or on the gaps in our knowledge of it, and it made only brief references to the analyses that were one of its essential bases. The related field notes etc. do contain further relevant material, but probing beneath the surface was limited to what was needed to check specific hypotheses.

A two stage approach is now required.

The first stage should chiefly summarise the most relevant existing knowledge in convenient form (perhaps largely by means of annotated drawings), making good only those gaps in knowledge that can easily be filled by further inspection - by the inspection, for instance, of working masonry that is already accessible behind locked doors or is newly laid bare for such purposes as re-leading of the roofs. Van Nice 1965 and 1986 and Mainstone 1988 and the related archives would be the main sources, though the Mainstone archive is not yet in the public domain and to pick out what is relevant to the assessment of safety calls for a good prior knowledge and understanding of the structure. Where the gaps in knowledge cannot be made good without additional investigation they should simply be identified and the desirable investigations specified. But a full specification of monitoring requirements should be possible at this stage.

The second stage should be the investigations needed to make good the principal remaining gaps. At and above ground level this will call chiefly for limited further uncovering of the working masonry, supplemented by the use of endoscopes or video cameras in small diameter boreholes and/or by non-destructive tests (thermography, radar etc) for continuity and soundness and the presence of hidden voids. Uncovering will probably be most desirable and easiest on some faces of the main and buttress piers that are now covered by recent plaster. Some in-situ and mostly non-destructive tests of strengths, deformation characteristics and local stress levels (pulse velocity, rebound, scratch width etc with the necesary laboratory calibrations, and flat jacks), may also be desirable, though their value is more open to question since they are unlikely to give reliably representative values

for the large cross sections of the main elements and they are mostly less important (bearing in mind average stress levels and the likely character of seismic responses) than existing cracking. In addition to these explorations and tests, some attempt should be made to assess by suitable non-destructive means (perhaps including gamma-radiography) the continuity and likely effectiveness of the principal existing iron ties and the reinforced concrete one placed around the dome base in the most recent major structural intervention.

Below ground, the most likely need is for a continuation of the recent non-destructive tests supplemented by geotechnical boreholes around the building and limited excavation or core drilling alongside some of the piers to confirm the foundation depths, dimensions and character.

Monitoring of long-term movements

Studies of past behaviour (Mainstone 1988, 1992) show that the critical movements have been the progressive separations of the springings of the main east and west arches resulting from progressive tilting of the supporting piers. Future separations and inclinations should be monitored directly. Also desirable is monitoring of the openings of some of the cracks and joins that have contributed to the inclinations. These will include several of those over which glass tell-tales (now useless) were fixed in 1910-11.

The precise locations for all this monitoring and for that of seismic response should be specified as part of the appraisal of present knowledge as noted above.

Monitoring of seismic responses

We welcome the installation of digital strong-motion accelerometers in time to record responses to the March 1992 earthquake. The responses have shown the expected significant reduction in frequency with increase in amplitude (Mainstone 1992) as well as confirming the greater movements at the SW that were to be expected from prior evidence of greater cracking of the masonry of the SW pier.

This instrumentation should remain and should be supplemented by the installation of further transducers to clarify the modes of response. These should include a) further accelerometers at gallery level and at the corners of the dome base and b) suitable transducers to record opening and closing and/or relative slips at selected cracks and open joints (possibly proximity gauges or Hall-effect gauges).

Monitoring of the external and internal environment and other studies relevant to damage by excess moisture

Decay of materials also has a bearing on structural safety as well as on the durability of the decorative finishes discussed below. Some materials (notably those used for surface finishes) have, for instance, suffered from the crystallisation of soluble salts as a result of excess moisture movements (Massari 1992). There have been three principal sources of this moisture: rain penetration through broken windows and unsuitable or ill-maintained roof and wall coverings, rising damp from foundation level, and condensation. Some remedial

works are essential to reduce or remove the sources. To guide these works and indicate priorities there is a need for further studies and monitoring.

Recent local stripping of the lead sheeting has, for instance, shown very different bedding conditions and thicknesses of lead varying from 1mm to 3mm: a fuller study of the moisture content of the brickwork under the lead at representative locations would be helpful.

For a wider understanding of the present conditions and a continuing check on them we support Massari's suggestion (1992) for surveys of external micro-climate and the environmental conditions within the building and we recommend their subsequent monitoring by permanently installed and automatically recording electronic equipment in positions selected on the basis of these surveys. The measurements should include air and masonry temperatures, air and masonry humidities, air pollution (mainly SO_2 and SO_3), and underground water table levels (using piezometers installed in external borings and perhaps also in internal borings near the feet of the main piers).

Parallel further studies of the mechanisms of decay of the mortars, bricks and marbles, together with estimates of the residual strengths of apparently badly decayed brickwork would assist.

5 NOTE ON THE MINARETS

The above comments and recommendations are made primarily in relation to the building itself. Thought should also be given to the minarets as the most important Ottoman additions.

Only a partial inspection of the NW minaret was possible on the last day of the mission proper. Bearing in mind the likely nature of future seismic response, the absence of any obvious signs of weakness of the masonry of the kind now very apparent in one minaret of the Sehzade Mosque suggests that there is no risk to this Hagia Sophia minaret in the foreseeable future. Subsequent external inspections of the other three minarets supported by recollections of earlier ascents of those at the SW and SE suggest equally little risk to these.[2] But closer inspections of all four are desirable, plus the installation of strong-motion accelerometers on each.

6 INTERIOR DECORATION

Some ten thousand square metres of the piers, walls and vaults were originally covered in marble and mosaic which were one of the glories of the building. Polished marble revetment and opus sectile covered the faces of the piers, the walls of the narthex, aisles and galleries, and the soffits of the arcades around the nave at ground-level, complementing the marble monoliths of the columns. Most of the soffits of the vaults and arches and most other faces not so revetted were covered in gold mosaic bearing non-figural decorative patterns. These mosaics, the varied colours of the marbles from many different sources, the careful exploitation of their natural veining, the carving

of soffit slabs, cornices and capitals, and the ample lighting gave the whole interior a sumptuous luminosity. Figural mosaics were later substituted in prominent positions on the main high vaults and many of the gallery vaults and in a few places on the flat surfaces of the walls - notably in the south gallery and on the great north and south tympana - without detracting from this overall effect.

Present condition and current work: non-figural mosaics

Much of the original non-figural mosaic remains in situ on the vaults of the inner narthex and the aisles, on the soffits of the exedrae arcades at gallery level and on the 6th century sectors of the dome. On the soffits of the lateral arcades and tunnel vaults of the gallery, on the tympana and elsewhere on the dome and other high vaults, there are extensive further survivals of later date, though there has been proportionately more loss in some of these positions.

Until recently very little attention has been paid to these mosaics - either to their precise dating or to their cleaning and conservation. But a detailed study of the dome mosaics was commenced in 1992 from a substantial scaffold under the NE quadrant.

We were impressed by the high professional quality of what has already been achieved here. The exact boundaries of the 6th, 10th and 14th century mosaics and of the 19th century and later interventions have been established and much more has been learnt about the techniques adopted and the present condition. Were it not for obstructions occasioned by working practices in the museum and by one shortcoming in the scaffold, even more could have been achieved.[3] Apart from making good this shortcoming (which has precluded direct access at and slightly above the level of the window heads) we suggest that in future the team of experts is enlarged from 4 to 6 and that they are allowed to continue work after the museum is closed to the public. That should call for no more than keeping one guard on duty, entailing only a very minor expense in relation to the other costs.

Close inspection has shown the precarious state of some of the mosaic and the very different characters of the work of different periods which had been far less noticeable from the floor below. Work of high quality in the 6th century contrasts with much poorer work in the 14th and there is a marked contrast even between the Fossati interventions and later ones modelled on them. Some cleaning and the removal of rusting nails are clearly desirable. Once this is done, difficult decisions are called for about how best to conserve, or partly replace, what now exists. Ideally these decisions should be taken only in the context of the wider consideration of the whole internal aspect of the building referred to below.

The similar mosaics at ground level are now much obscured by Fossati over-painting, though partly visible through it in good light. Present indications are that they will present fewer problems. There is not the juxtaposition of work of many different periods that is seen in the dome, and the main need may be simply for careful cleaning and limited consolidation. The reward would, on the other hand, be greater. The effect could be dramatic.

Figural mosaics

Most effort over the past 60 years has been devoted to the figural mosaics which attract most attention from visitors. The documentary and graphic evidence have been reviewed by Mango (1962) and the cleaning, dating and conservation have been well reported in numerous publications of the Byzantine Institute and later of Dumbarton Oaks. The survivals still calling for attention are the figures of the Virgin Mary, John the Baptist, the emperor John Palaeologus and the Etimasia on the soffit of the main eastern arch (disclosed during redecoration of the eastern semidome some five years ago but not then cleaned and consolidated), the Seraphim on the eastern pendentives, and fragments of other figures (including the lower part of a gigantic Isaiah) on the tympana. A brief close inspection by Mango in 1989 of the figures on the arch showed them to be of the highest artistic and historical importance, while it is likely that the faces of the Seraphim still exist under the metallic stars. We recommend that while the present scaffold is in place the northern Seraph should be cleaned and that the scaffold itself should be extended eastwards to permit the cleaning and consolidation of the figures on the northern part of the eastern arch. Similar work should be undertaken at the south when the scaffold is moved to that side.

Marble revetments and opus sectile

These survive to a large extent from the original construction on faces turned towards or visible from the central space. In the aisles and galleries they survive only in part, but sufficiently to show the whole original scheme. Their present dirty state leaves much to be desired however. Though there appears to have been some recent cleaning, the overall impression is dull, dingy and almost colourless - far from the splendour of Byzantine, and probably even of early Ottoman, times.

Further cleaning by well proven techniques would clearly be beneficial and probably some further simulated marbling of the faces where the original has been lost. But this also should be carefully considered in a wider context.

Overall strategy for the interior

There is thus an urgent need for a clearly formulated overall strategy for the conservation of all these features and the making good of losses. The Venice Charter has laid down general principles. But it is necessary to formulate a strategy to meet the specific requirements of this unique and supremely important building.

There are two major difficulties to be faced, even in choosing the best approach. One is the great change in the light under which the interior is now seen as a result of the blocking or partial obstruction of many windows, especially at ground level. Where the blocking or obstruction is caused by added external buttressing, the change is effectively irreversible except perhaps by the judicious introduction of some new artificial light sources. The other difficulty is the inescapably different effects of changes in light with time of day, season and weather on the apparent colour and brightness of different types of surface. Lacunae made good in painted plaster, for instance,

may be unobtrusive in one light yet disturbing in another light. Changing reflections from surface to surface also affect appearance.

In these circumstances judgements should be made only on the basis of long familiarity under all conditions of light. And since, even with that experience, no two experts are likely to come to indentical conclusions, wide consultation seems especially desirable - perhaps on the pattern of the consultations that have been taking place to guide the current exemplary work on the Acropolis in Athens. Despite the desirability of an overall strategy it may also be helpful, as in Athens, to approach it in stages. Lacunae present a much greater problem on the tympana, for instance, than on the dome and in most other places, so that experience here could help to guide later work elsewhere.

7 EXTERNAL COVERINGS AND FINISHES

Reference has already been made to the large variations in thickness of lead etc. disclosed by recent exploratory stripping of the roof coverings. Some further investigation is desirable, followed by a detailed scheme for systematic repair or replacement. This scheme should embrace substratum, timbers (where necessary) and underfelt, as well as thickness, size, cutting and jointing of the lead. A 3mm thickness is recommended, preferably of recast old lead whose impurities have usually been found to confer greater durability.[4] Other recommendations were made by Mainstone last year at the request of the Consultants' Committee including size of sheet, underfelting, and the prime importance of detailed pre-planning of cutting and working sequences and of adequate protection from rain of all uncovered areas. In this last connection we noted with alarm during our inspections that, after recent stripping, brickwork had been left unprotected in several places at a time of heavy rainfall. This must not be allowed to continue or to happen again.

Most wall faces and exposed arch soffits have stucco rendering. Much of it was renewed at the upper levels almost 40 years ago and there was a more extensive redecoration in pink wash some 5 years ago. This choice of colour was a mistake. It is understood that further re-rendering is now intended, calling for further redecoration. The mix should be sufficiently permeable to avoid trapping water in the brickwork and should be chosen only after taking appropriate expert advice. Also the importance of taking steps to minimise exposure to rain during the work is again emphasised. Past experience shows that it is easier to achieve a reasonable uniformity with a yellow-buff colour and that this is less noticeably discoloured by subsequent weathering.

The original marble revetment remaining on the west front and the marble panels at the feet of the windows should be carefully conserved.

8 RECORDING

Uncovering of the working masonry as other work proceeds should clarify some details of the construction and structural history of the building

if properly observed, though the history is now well known in most essentials.[5] To supplement the Van Nice Survey (Van Nice 1965 and 1986) and the related field notes, significant finds should be fully recorded both in drawings and photographically. All other evidence brought to light since 1969 (eg by the uncovering of the masonry in the NE ramp or by excavation) should be also be added to the record and recent photogrammetric surveys of the dome and semidomes (which have the advantage that the data are digitised) should be correlated with the earlier plans and sections.

As a longer-term objective, it would be helpful if all measurements (including those at present existing only in the form of field notes and unpublished drawings) could be centrally stored and similarly digitised. But this would be a huge undertaking as well as calling for intimate knowledge of the building and the agreement and cooperation of those at present holding the data and owning copyrights. It should not be allowed to delay more urgent work.

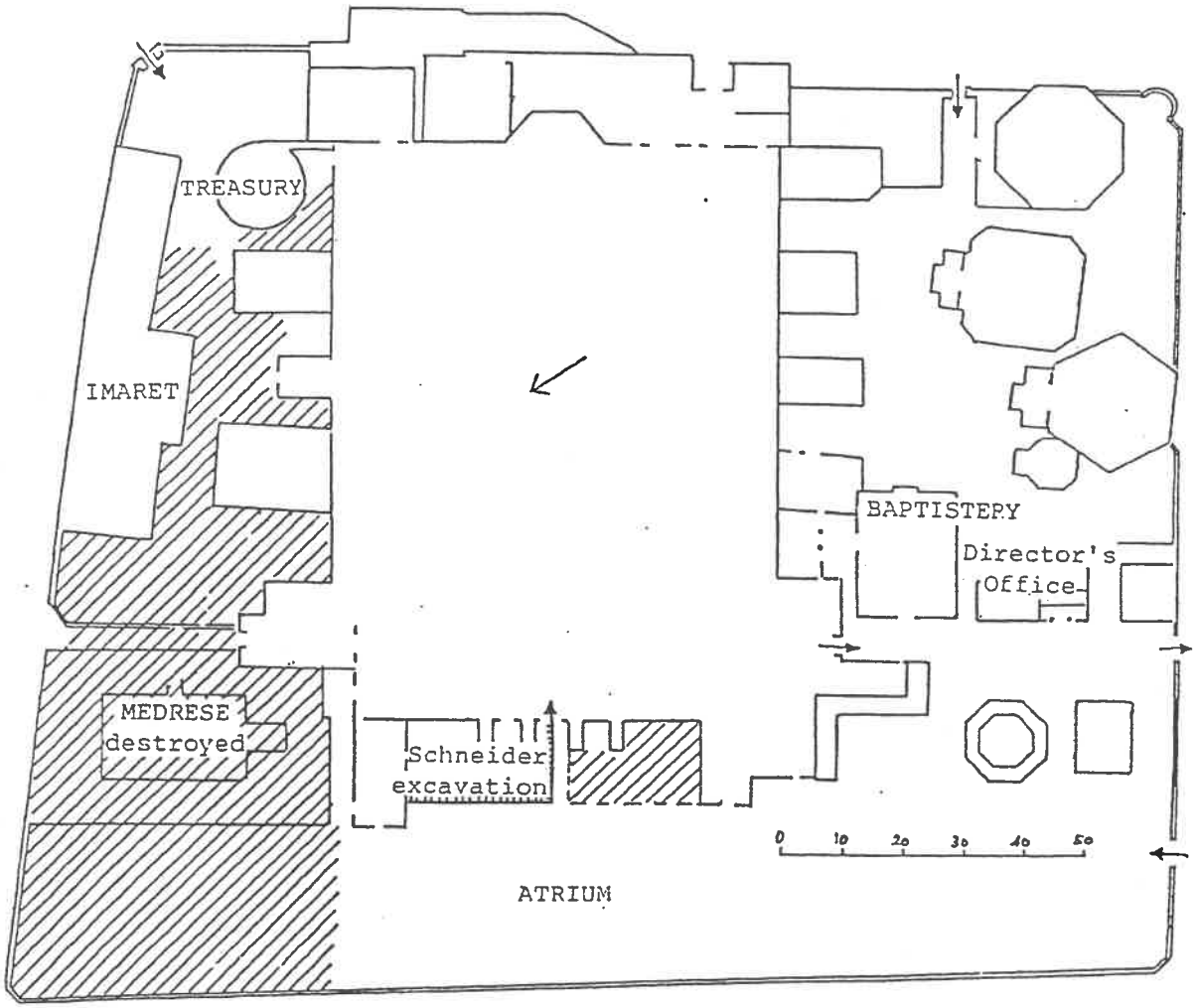


Fig.4 Sketch plan of the area within the Museum perimeter wall with approximate areas suitable for excavation shown hatched (Mango)

9 ARCHAEOLOGICAL INVESTIGATION

Much less is known of the earlier churches on the site than about the present building. The only significant excavation ever undertaken, that of A M Schneider in the NE segment of the Justinianic atrium (1935), resulted in the spectacular discovery of a Theodosian facade (probably that of the Theodosian atrium rather than of the church itself). Eventually an extension of Schneider's excavation to reveal the other half of the facade while leaving sufficient access to visitors is highly desirable, plus some selective soundings underneath the present floor.

It should also be remembered that Hagia Sophia was not an isolated building. As the cathedral church it had important dependencies abutting on it: the patriarchal palace, library, two baptisteries, treasury, school, outlying chapels, etc. There have been some minor findings south of the surviving Baptistery and behind the Director's office (1939), and outside the central north door of the church where a marble Byzantine pavement was revealed then allowed to become covered with earth (summary report Koyunlu 1990). One may also mention the emptying out of the circular Treasury which used to be filled with earth to a depth of 6m. (summary report Türkoğlu 1983).

In a comprehensive project it would be a great pity to neglect further external archaeological investigation of these dependencies within the perimeter wall of the Museum before it becomes too late as a result of of the erection of new structures, the re-arrangement of the lapidary exhibits or the ultimately desirable partial repaving and landscaping. A more serious investigation of the Treasury with exterior soundings is highly desirable. It is also desirable to conduct scientific excavation on the site of the destroyed medresse, within the northwest angle of the perimeter wall and along as much of the north side of the church as may be practicable (fig.4).

10 RECOMMENDED FUTURE ARRANGEMENTS FOR OVERSIGHT, CONSERVATION AND RESTORATION

The establishing of the Consultants' and Advisers' Committees are welcome steps towards the better safeguarding of the monument. The Consultants' Committee brings to bear a wider range of expertise and the pooling of ideas and joint discussion of proposals in the Advisers' Committee reduces the risks of a piecemeal approach, with actions taken in pursuit of one objective being unnecessarily inimical to another. But we doubt whether they go far enough.

In discussions both with officials of the Ministry and with others such as Professor Ilhan it was repeatedly suggested that, to overcome fully the difficulties arising from divided responsibilities, there was a need for a "Hagia Sophia Institute" to exercise full responsibility for the monument.

We strongly support this suggestion, questioning only the name which might be misunderstood as denoting a primarily academic role.

We see such a body as the counterpart of the permanent organisations

that have long been responsible for the care of other major historic buildings under a suitably qualified person variously known as, for instance, the Proto, the Architect, Engineer or Surveyor to the Fabric, or the Dom Baumeister. Once established, its responsibilities would include the commissioning and supervision of all necessary studies and research, the granting of facilities for legitimate academic research, the collection of all relevant data as suggested above, the preparation of preliminary schemes for all interventions thought to be necessary, the selection (subject to ministerial approval) of external consultants and contractors, and liaison with the Museum Director and other bodies.

Whether the head of this "Institute" be architect or engineer is less important than that he should have suitable experience in the care and restoration of major historic buildings and be able to command considerable authority, reporting directly to the Director General of Monuments and Museums. Because of the international importance of the building and because some problems it presents have no counterparts elsewhere in Turkey, he should be able to draw on relevant expertise from abroad as well as having the support of a skilled permanent staff and an enlarged Turkish Consultants' Committee.

As an interim measure, pending the establishing of this "Institute", we suggest giving the Advisers' Committee a role and a status more akin to that proposed for the new Institute and giving it appropriate full-time assistance, preferably in a small office near the monument. Among its tasks might then be the devising, in collaboration with the Directorate of Surveying and Monuments, of a regular inspection and maintenance scheme and, more specifically, the preparation and supervision of the now urgent plan for renewing the lead covering of the roofs.

11 SUMMARY OF RECOMMENDATIONS

Summarising what has been written above, we consider and recommend:

in relation to responsibilities and administration:

1) that recognition should continue to be given by the Turkish authorities to the importance of Hagia Sophia/ Aya Sofya in the world architectural heritage (section 2).

2) that in view of this importance and the special problems presented it would be wrong to entrust the investigation of conservation and restoration needs and the planning of desirable works to a contractor, however enthusiastic and competent in his own field he is.

3) that, as has been suggested to us by Turkish colleagues, there should be a new body ("Institute") reporting directly to the Director General of Monuments and Museums to undertake these responsibilities and, more generally, to be fully responsible for the monument with the assistance of an enlarged Consultants' Committee (section 10).

4) that full use should continue to be made also of internationally recognised experts to advise on major decisions on specific problems that lie outside present Turkish experience (section 10).

in relation to investigations and works of conservation or restoration:

5) that no action should be taken on the works tentatively suggested by Net Yapi and others until they have been more fully considered (section 4).

6) that there is no evidence of immediate risk to the structure but that there should be a full appraisal of what is now known about it followed by further investigations and monitoring to serve as a basis for considering possible strengthening measures and realistically analysing their effects on the response to possible future earthquakes (section 4).

7) that there is an urgent need for the repair/renewal of the lead covering of the vaults and for its future maintenance (section 7).

8) that there is a need for the cleaning and consolidation of much of the internal mosaic decoration and marble revetment and some making good of losses, and for the formulation, with advice from recognised experts, of an overall policy to guide this work (section 6).

9) that, in relation to both 7) and 8) there is a need for further study of moisture movements and condensation and their effects with the objective of reducing damage to materials and finishes (section 6).

10) that, before other developments make it too difficult, some further excavations should be undertaken to add to our knowledge of the history of the monument, of its ancillary structures, and of its predecessors on the site (section 9).

11) that the findings, both of these excavations and of all other investigations, should be fully and centrally recorded, preferably on a data base of all previous observations and measurements (section 8).

12 FUNDING

We consider that the international importance of the monument justifies an international contribution to the costs of caring for it and preserving it for the future. Until some of the studies recommended above have been completed and desirable works specified no estimate of the eventual total cost is possible, though structural monitoring alone could cost up to several hundred thousand US dollars. We suggest looking into the possibility of a UNESCO initiative to seek voluntary contributions, particularly from states of the European Union. To this end, UNESCO funding of the recommended preliminary studies would be desirable to provide a firmer outline of needs and a costing basis.

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NOTES ON THE POSITION IN OCTOBER 1994

1) the suggested measures have not been considered by the Consultants' Committee and corrections of irregularities are not intended.

2) natural frequencies of the SE and SW minarets measured by Professor Hidaka are likewise stated to suggest no immediate danger.

3) the shortcomings of the scaffold were reduced in 1994.

4) 3mm lead sheets are now being used.

5) features exposed by stripping of the external rendering are now being surveyed by a team of architects supervised by Professors Metin Ahunbay and Zeynep Ahunbay.