The CSA Propylaea Project

Introduction and Project Summary

The entrance building to the Athenian Acropolis, called the Propylaea, is one of the most significant architectural achievements of antiquity. The second of the great structures of the Classical Acropolis, built just after the Parthenon, the Propylaea combines functions and structural parts into a complex whole that is unparalleled until the introduction of Roman concrete. The architect, Mnesicles, planned an even more complex structure, but the two eastern wings of the building were never finished. Famous even in antiquity, the building survived, though greatly modified, to be restored starting in the first decade of in the twentieth century. Much of the restoration work was inadequate; so new work was begun in the late 1980s to study, stabilize, and restore the Propylaea. The director of that work is Dr. Tasos Tanoulas. Under his direction the restoration and stabilization work has generated an enormous amount of new information.

The final results of the work on the Propylaea will be the partially restored building itself and a great deal of new information about the building — information in the forms of drawings, notes, photographs, and written materials. The building itself will last for some time, and it is there for all to see. The information, however, is fragile, hard to find, and accessible only to the *cognoscenti*. Problems with accessibility have to do both with gaining physical access and knowing how to utilize the materials once they have been found.

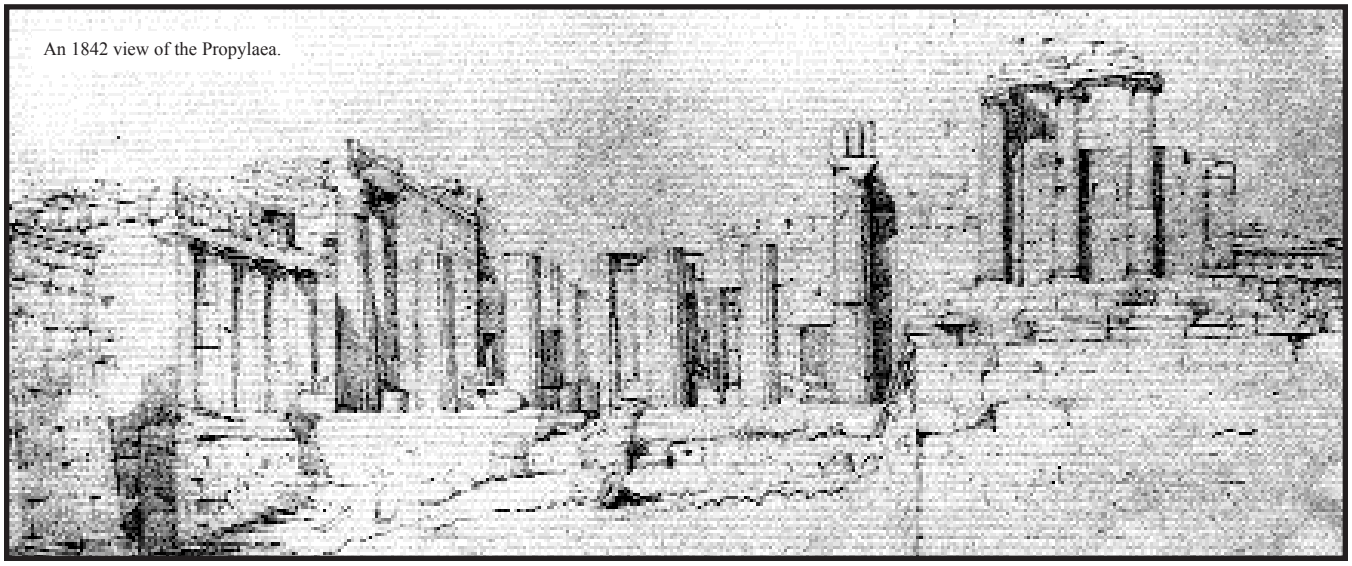
To provide better access to the information generated by Mr. Tanoulas and to preserve that information for the future, CSA Propylaea Project personnel will put all the data into digital forms, make the files available via the Internet, and archive the files to prevent decay or obsolescence. The most important portion of the digital data will be a computer-aided design (CAD) model. The model will be fully three-dimensional (as drawings cannot be), and all dimensional information will be retrievable at originally measured precision (impossible when dealing with scaled drawings). Attached to the model will be digitized versions of the original drawings, photographs, notes, and other written materials in the project offices. The fact that the information is in digital form is not really the issue; the issue is that, being digital, the information may be accessed easily and fully. That level of access is truly revolutionary.

This is an unprecedented approach to documenting an important building; as a result, its value lies not only in the fruits of the project itself but also in the demonstration of the techniques used. The modeling will be done stone-by-stone, not from idealized parts, and the resulting files will be in the standard AutoCAD format, thus useful to the widest possible range of scholars. (Archiving procedures will prevent obsolescence as formats change over time.) In the end, virtually everything that has been learned about the building will be available through the CAD model and associated files. At the same time, the process for documenting the Propylaea will have been demonstrated and explained so that others may apply it to their own work.

Approach and Work Processes (see Appendix A for details)

The CSA Propylaea Project is a cooperative project involving Mr. Tanoulas; Mary Ioannidou, the structural engineer working with him; and the Center for the Study of Architecture (CSA) and its Director, Dr. Harrison Eiteljorg, II, an acknowledged expert in the application of computer technology to archaeology. The project is, in part, an outgrowth of a long and fruitful relationship between Mr. Tanoulas and Mr. Eiteljorg, fostered by Mr. Tanoulas' visit to the U.S. as a Kress Lecturer for the Archaeological Institute of America in 1994/5. Mr. Eiteljorg will be the director of the project; Ms. Ioannidou will oversee the work in Athens; Mr. Tanoulas will coordinate the work of this project with the work on the monument itself. CSA will be the institutional sponsor. (CSA is a 501 (c) (3) not-for-profit Pennsylvania corporation.)

As stated above, the CSA Propylaea Project will involve digitizing the records created by Mr. Tanoulas and his colleagues, archiving the digital files, and making the information available to scholars and others, in computer form. The



An 1842 view of the Propylaea.

information will be useful to scholars who wish to study the evidence and to reconstruct that which has disappeared as well as to popularizers who want to offer information about the building to a general audience.

The CSA Propylaea Project will involve the following: The portions of the building that have been surveyed will be modeled with AutoCAD, existing drawings will be scanned, photographs will be digitized, and written materials will be entered into the computer. As the project progresses, the various kinds of information will be inter-connected so that users can access relevant information from a variety of starting points via a site on the World Wide Web. The data will be archived in standard file formats for preservation in perpetuity (through the Archaeological Data Archive or a comparable archive). Articles will be written about all stages in the process.

The first phase of the project will last three years and will see the completion of the CAD model and the scanning of drawings for all portions of the Propylaea that have been documented by Mr. Tanoulas' team. In addition, articles describing the work will be published (in both popular and academic publications), and information about accessing the model will be widely disseminated. Most of the thousands of photographs in the Propylaea files will be digitized in the first phase as well, and some photo-realistic renderings of the building as it stands today will be created. The Web site will also be opened during the first phase of the project. It is this first phase of the project for which the support of the Samuel H. Kress Foundation is being sought.

The second phase will conclude the digitizing of photographs, and the entry of texts will be accomplished. Additions to the base data will also be made as work continues on the structure, and the Web site will grow in completeness and complexity. The third phase will consist simply of keeping the data current as work on the Propylaea continues. It is possible that there will be a fourth phase — direct data entry into digital form without intervening drawings — but that involves answers to questions that have yet even to be asked.

The CAD modeling will be of three kinds. One, blocks that have been removed from the building for study or consolidation will be modeled as solid objects and as if they were in their original condition. Connected to the models of the blocks will be scans of the existing drawings of their surfaces so that proper senses of the current states of the blocks can be obtained. Two, although some blocks remaining *in situ* may also be modeled as solids, most of the *in situ* blocks have only one or two visible surfaces. Therefore, surface models will be made of their visible surfaces only. The more complex shapes (fluted column drums, Ionic bases and capitals, various moldings, and so on) will require a variety of approaches, depending in each case on the available information and the desired use in the model. Three, in addition to solid models and surface models, there will be line art to indicate graffiti and other marks on walls, possibly drawn with the aid of photogrammetric systems. The solids, surfaces, and lines will exist in a single model, together composing a model of the remains of the Propylaea as found

The central portion of the Propylaea from the approach below.

today. (A variety of aids will be employed to speed the modeling process, including spreadsheets and/or databases into which data may be entered and from which CAD items can be modeled automatically.)

Connected to the CAD model will be one or more data tables to contain explanatory information about individual blocks, walls, or other parts of the building, as well as comments about the modeling process. That information will be entered in Greek and English.

The CAD model will be the core of the data set; the digitized drawings, notes, descriptions, and photographs will augment and enhance the model. The model itself will be fully three-dimensional and at full scale. (All data points in a CAD model have coordinates that are recorded and retained in the data file without alteration by any scale factor. Thus, querying the model can provide full and accurate retrieval of any measurements or point locations in the file. Finding dimensions from paper drawings, on the contrary, always entails a loss of precision due to the scale factor; the smaller the drawings scale, the greater the loss.) Three-dimensional views, isometrics or perspectives, may be obtained from any vantage point. Since a CAD model is both three-dimensional and at full scale, it supplies the best possible foundation for subsequent use, whether data verification, analysis, detailed reconstruction by scholars, or presentation reconstruction for a general audience. The dimensional information is complete and retrievable, and the precision of the model provides a check for reconstructions.

The utility of CAD is further enhanced by the fact that items in CAD models can be segregated from one another according to any desired criteria. A user, understanding the criteria used to segment the model, may view any of the segments alone or in combination. Thus, a user could see the original portions of the Propylaea in isolation, or only the modifications of a specific period, or the original portions with modifications up to a certain point in time, or . . . . Indeed, even competing restorations can (and surely will, at some time) be stored in the model simultaneously so that each may be seen and compared to other suggestions. (For more information about CAD, see the CSA Web site at http://csa.brynmawr.edu/csa.html and the Web pages that make up the *CAD Guide to Good Practice* written by Mr. Eiteljorg in collaboration with the Archaeology Data Service in England, beginning with http://csa.brynmawr.edu/web1/g2gp/G2GPDraftIntRev.html.)

Most of the work will be done in Athens, either in a rented flat or in the office of an architectural firm. The latter is preferred but cannot be arranged until the project is a reality. One full-time employee will work on the CAD model and scan the drawings. That employee will also scan the photographs; keyboard entry of text may be contracted. In this first phase of the project, however, the emphasis will be on the CAD model, the scanned drawings, and the photographs.

While the modeling and scanning are continuing, Mr. Eiteljorg will be writing articles for the *CSA Newsletter* and other publications concerning the work processes. Two brief notices about the project have already appeared, and an article concerning work done this last February will appear in the next newsletter. Other publications based on the work can be expected, as can presentations at scholarly meetings; readers should have ample information to guide similar work on other projects. The *CSA Newsletter* and other electronic media will also be used to let potential users know of the availability of the model. Of course, the Propylaea Web site will also be used to disseminate information about the project. It will be designed to present information to scholars and to a broader public.

The full-time employee will be a beginning architect who is already familiar with AutoCAD. Ms. Ioannidou and Mr. Eiteljorg will hire the architect and check his/her work for quality and accuracy. Ms. Ioannidou will work with the architect to supply the necessary drawings and access to the Propylaea records. Mr. Eiteljorg will train the architect in the scholarly use of AutoCAD, both in Athens and via email. Mr. Eiteljorg will also work with the architect to create aids to speed data entry. Throughout the first year of the project, Mr. Eiteljorg will keep very close tabs on the work, making certain that the model progresses well and that appropriate tools for making the processes more efficient are used. As the work progresses, the need for close supervision as to work processes will diminish, but Mr. Eiteljorg and Ms. Ioannidou will continue checking for accuracy and completeness throughout the life of the project.

The architect will also be responsible for scanning drawings and digitizing photographs as they are added to the system. He/she will be responsible for documenting the work and the data files as required for archival storage. He/she will indirectly aid the work on the Propylaea by alerting Ms. Ioannidou to data missing from the existing drawings.

The project Web site will be constructed and maintained by Mr. Eiteljorg and CSA staff members. The basic site will be established immediately, but significant additions of material will not begin until the second year of the project.

A Pentium II laptop has been provided by CSA already and is now in Athens. A monitor, keyboard, back-up storage device, large-drawing scanner, and printer will be required, and the computer will be upgraded at some point. A digitizing tablet may also be needed, but that does not seem likely at this time. Eventually a slide/film scanner will be purchased. CSA has normally been given AutoCAD by the manufacturer; so software purchases will be minimal.

Some work has been done to get the project started. A laptop computer, with AutoCAD, was taken to Ms. Ioannidou in 1998 (subsequently replaced with the laptop now in Athens), and Ms. Ioannidou has taken an AutoCAD course. In February of 2000 Mr. Eiteljorg went to Athens so that he, Ms. Ioannidou, and Mr. Tanoulas could test operating procedures and finalize the nature of the project. At that time Ms. Ioannidou and Mr. Eiteljorg discussed ways to enter data and to make the data entry process more efficient. Mr. Eiteljorg modeled one of the ceiling coffers and wrote a description of the process; he also developed a spreadsheet into which data about wall blocks could be entered from existing drawings and which would, in turn, generate AutoCAD commands to model the blocks. Surface models of one face of each of about 50 blocks were made in just over

The northwest wing and part of the central portion of the Propylaea from the approach below.

an hour with the aid of that spreadsheet. It was during that work in February that Mr. Eiteljorg and Ms. Ioannidou realized that work on this project could alert Propylaea personnel to minor omissions from the drawings.

The work done thus far (and Mr. Eiteljorg's work on other projects) has shown that CAD models often require data points that cannot be irrefutably defined. In those cases, discussions of the inferred data will be written and made available to users so that anyone using the model can understand the CAD operations, modeling choices, and decision-making processes that were used. This will slow the modeling work, but it will add to the value of the project. As the first stone-by-stone CAD model of such a large and significant structure, the Propylaea model should serve as a model of proper procedures as well as a model of the Propylaea.

During the second and third years of the first phase of the project a fellowship will be offered to graduate students of archaeology or architectural history. The fellowship will enable one student each year to learn the scholarly use of AutoCAD under the direction of Mr. Eiteljorg and then to spend some weeks in Athens working on data entry with the architect. (Funds for this fellowship are not included in the proposal. They will be obtained elsewhere.)

Scheduling (see Appendix B for more details)

The schedule for this project is very difficult to predict. There are no precedents. Therefore, the following must be taken as tentative. Even the order is not as simple as it may seem. For instance, beginning work will include all data types so that questions surrounding data connectivity will, from the beginning, be seen in their full complexity.

Year 1, months 1 through 3:

* Prepare a work plan, laying out the order in which modeling will progress and detailing drawings that will be required.
* Prepare the job description, make office and equipment arrangements, interview candidates, and hire architect.
* Construct basic Web site.

Year 1, months 4 and 5:

* Train the architect in use of AutoCAD in this setting.
* Determine initial procedures for project activities, including reporting requirements.
* Create databases for drawings.
* Prepare article(s) regarding the methods chosen to connect drawings and CAD models.
* Prepare article(s) on training issues, as suggested by experience.

Year 1, month 6 through year 2, month 2:

* Model ceiling coffers and enter relevant information in database.
* Create solid models of roughly half the blocks that have been removed from the building; position them within the building, when possible.
* Scan block drawings, link models to scans, enter drawing information in database.

* Create surface models of interior surfaces of standing walls.
* Scan wall/area drawings, link models to scans, enter drawing information in database.
* Prepare articles on progress and specific problems/procedures.
* Add to Web site.

Year 2, month 3 through year 2, month 12:

* Complete modeling of blocks that have been removed from the building and related tasks.
* Create surface models of exteriors and related tasks.
* Refine surface models of walls.
* Begin surface models of entablature blocks and other parts of superstructure.
* Experiment with ways to represent columns/column drums, bases, capitals, and other complex shapes.
* Begin establishing procedures for digitizing of photographs.
* Prepare database for photographs.
* Prepare articles on progress and specific problems/procedures.
* Continue adding to Web site.

Year 3:

* Complete models of building superstructure, adding selected restorations already worked out by Mr. Tanoulas.
* Model column drums, bases, capitals, etc.
* Digitize photographs.
* Work out remaining integration issues relating CAD model, drawings, photographs, and text.
* Add line drawings of graffiti, inscriptions, and other wall markings to model.
* Complete documentation for CAD model and deposit model in archive.
* Begin to work on visualization issues and create photo-realistic computer illustrations of the building in its current state.
* Publicize the results at academic meetings, over the Internet, and the like.
* Prepare articles regarding procedures and using photo-realistic illustrations.
* Continue adding to Web site.

Conclusion and Future Plans

By the end of the three-year first phase of the project, the CAD model and scanning of drawings will be complete, and the availability of the information will be announced widely. Although it is unlikely that all the thousands of photographs will have been digitized, the majority should be in digital form, and the Web site will be operational. The CAD model alone will provide scholars with unprecedented access to information about the building. Scholars interested in metrics, the original building plan, architectural planning, and many other areas will find the model to be essential to their work. Indeed, any scholar interested in classical architecture will find this model to be crucial. In addition, scholars considering the use of the technology for their projects will consult this model and the articles describing its creation for assistance with the technical side of their work. The photographs and drawings, in digital form, will add considerable detail for scholars.

There will also be uses for the model that are less scholarly and aimed at a more general audience. It will be possible, for instance, to use the model to create virtual reality presentations of the Propylaea as well as a wide range of images of the Propylaea at various times in its history, the better ones seeming as “real” as photographs. The availability of CAD model, drawings, and photographs will also provide opportunities for a wider range of the public to understand the work of the scholar and to appreciate both the results and the processes. The Web site will provide an important avenue for this connection to the general public.

The later phases of the project will see the completion of the work with photographs, the addition of texts, and the work required to integrate the text. Of course, new information about the structure itself, produced by the on-going work of Mr. Tanoulas’ team, will also be added to the data sets already generated. The Web site will continue to evolve as well.

At the end of the first phase, information about the Propylaea will be qualitatively better, better organized, more widely available, and better preserved than for any other building from our past. While additional work will continue to augment the results, scholars and members of the general public will then have a unique and revolutionary resource available to them, as well as an example of a thorough, modern, carefully-conceived approach for documenting any important building from the past.

Budget

Year One

Architect (9 months)	$ 24,000.00
Ms. Ioannidou	6,000.00
CSA/Mr. Eiteljorg	15,000.00
Mr. Tanoulas	3,000.00
Travel	4,500.00
Space rental & utilities	4,500.00
Equipment	5,000.00
Misc. expenses & supplies	600.00
Total for year one:	**62,600.00**

Year Two

Architect (full year)	32,000.00
Ms. Ioannidou	6,000.00
CSA/Mr. Eiteljorg	8,000.00
Mr. Tanoulas	3,000.00
Travel	3,000.00
Space rental & utilities	4,500.00
Equipment	1,000.00
Misc. expenses & supplies	600.00
Total for year two:	**58,100.00**

Year Three

Architect (full year)	34,000.00
Ms. Ioannidou	6,000.00
CSA/Mr. Eiteljorg	8,000.00
Mr. Tanoulas	3,000.00
Travel	3,000.00
Space rental & utilities	4,500.00
Equipment	4,000.00
Misc. expenses & supplies	600.00
Archival fee	1,000.00
Total for year three:	**64,100.00**

Three-year total:	**$ 184,800.00**

Budget Notes

§ Calculations assume any inflation in Greece will be counteracted by changes in dollar exchange rates.

§ In several cases drachma figures were starting points, but then adjusted to produce rounded-off dollar numbers.

§ A beginning architect will not command as high a salary as someone trained in a computer-related field.

§ Travel is for Philadelphia-Athens trips and living expenses in Athens (at the American School of Classical Studies) for Mr. Eiteljorg. First-year travel is higher because of the anticipated need for a longer stay in Athens; in addition, it will be necessary to purchase a normal-fare ticket so that the return can be adjusted, depending on the time required for training.

§ First-year equipment: large scanner, printer, monitor, additional disk storage device, keyboard, furniture.

§ Second-year equipment: film/slide scanner.

§ Third-year equipment: computer.

§ Archival fees are impossible to predict at this point. Fee shown is an estimate only.

Appendices

Appendix A - Notes regarding Approach and Work Processes.

§ Archiving of digital records is a necessary part of a project like this. Without proper care, digital records are far more fragile than paper ones. With proper care, they should last indefinitely. The principal component of proper care is changing the file formats and media as computer technology changes so that the files can be accessed by new programs and/or on new machines. The archival storage requires extra documentation that might otherwise be ignored.

§ The Web site will provide direct access to some of the materials created by the project, but it will not provide online, immediate access to the vast majority of the drawings and photographs or the CAD model. Access to the CAD model is not possible today, though it may be in the future, and access to all the drawings and photographs would be very expensive and time-consuming to provide. Instead, access to the data files that provide information about all the drawings and photographs will be provided so that users may request the individual items they need. Those items can then be provided through any number of Internet protocols.

§ Scholarly access to the data from this project will be at no cost. Copyright will be held by CSA and/or the Greek government, however, and commercial users will be charged for use of the data in any venture involving commercial gain.

§ Modeling individual blocks will require standard CAD data entry procedures; the work will be relatively painstaking and slow. Blocks still in standing walls that have been surveyed and for which the visible surfaces have been detailed, however, can be modeled more quickly with the aid of a spreadsheet or database.

§ Although the architect will have CAD training, there are substantial differences between designing new items and drawing things that already exist. Regular shapes are easy to create in CAD; irregular ones are not. There are also important differences in the way CAD models are segmented if the models are to be used in commerce as opposed to scholarship. (The architect will spend at least half of one day each week on the Acropolis talking and consulting with the workmen, Mr. Tanoulas, and Ms. Ioannidou. That may slow the work, but it will increase the quality.)

§ Information about scans of drawings of individual blocks will be recorded in a database, and that work should be straight-forward. Drawings of large portions of the building, whether plans or elevations, will require more complex database information to be sure that such drawings can be related to all relevant parts of the CAD model.

§ Work to create photo-realistic views of the Propylaea will be modest. The intent will be primarily to spur others to work with the model and to determine the best ways to use it for such purposes. Nevertheless, the renderings may provide the general public's most lasting impressions of the project.

Appendix B - Notes regarding Scheduling.

§ The number of individual blocks thus far removed from the Propylaea is not known, but there are probably no more than 400. For each block there are at least 6 drawings (not necessarily on different sheets) that must be scanned. Thus, dealing with an individual block will take some hours. Modeling the block may take only twenty minutes of so if there are few cuttings, but could take much longer in the case of very complex individual blocks. Scanning, cleaning up the scans, entering information into the database, making the necessary links within the CAD model, and so on will take much more time. In addition, there will be some incomplete drawings, requiring that the work on the particular block be set aside until more information is obtained and reducing the efficiency of the work. Finally, placing the blocks in their correct positions, when those positions are known, will also add to the time required.

§ Creating surface models of wall blocks is comparatively fast and easy. More complex shapes, especially irregular ones, are very difficult and time-consuming to create. In addition, it will be necessary to model surfaces that are only partially visible, and that will be very time-consuming.

§ Complex shapes like Ionic column capitals will be modeled late in the project period, in the hope that better tools for such work will be developed. (For instance, scanners for large three-dimensional objects are now coming to market. Although they are prohibitively expensive today, they may be appropriate for this project in two or three years.) There are several ways to model such blocks, and the differing procedures can yield subtle but important differences in the appearance of the model.

§ The addition of graffiti, inscriptions, and the like will not occur until late in the project, because it will probably be necessary to use photographs as the primary data for drawing some of them.