USING THE MOSS ROAD-DESIGN PROGRAM IN MRD WA

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SUMMARY

Moss is a computer program for road design which has been developed in the UK and is currently being marketed in Australia. The MRD WA acquired the program in 1983 to supplement its own programs.

An outline is presented of MRD WA experience with this program covering the need for integration with survey processes, the suitability of the program for particular classes of road design, and the use of both printed and plotted output as construction documents. Some thoughts are presented on the integration of MOSS with other road-design programs and the long term possibilities of a comprehensive CADAD system for Computer-Aided Design and Drafting.

1. WHAT IS MOSS

MOSS Is a computer program which the MRD WA is using for road design. The name stands for MODELLING SYSTEMS, and refers to the basic concept by which a project is described as a series of 'models', each containing a three-dimensional picture of some aspect of the project. The MOSS program provides facilities for the storage of models and a comprehensive set of easily used computational options which allow the user to create, develop and display models.

MOSS was developed by a consortium of three UK counties (Durham, Northampton and West Sussex) but is now made available through an independent organisation, MOSS Systems Ltd. It is being actively marketed in Australia by Tritek Systems Pty Ltd of Melbourne.

2. BASIC CONCEPTS OF MOSS

There are three basic concepts which need to be understood before we can look in detail at the use of MOSS for road design. Firstly, there is the concept of strings as a means of storing information about a design project. Secondly, there is the concept of models as a means of grouping related strings together. And thirdly, there is the concept of options to specify the computations and processing to be carried out by the program.

The development of the string and model concepts on which MOSS is based arose from inadequacies in the conventional road design techniques in which both ground and design surfaces are described by cross-sections perpendicular to the alignment of the road. This is adequate for straightforward sections of road, but it breaks down for the design of channelised intersections and freeway interchanges where parts of the feature being designed can be oriented at all angles. The developers of MOSS found that both ground and design surfaces can be better described by means of 'strings' which can be oriented in any appropriate direction according to the needs of the feature being described.

A string is essentially a set of points described by three spatial coordinates and sometimes with further attributes. For example, a road centreline would also have chainage, bearing and curvature defined at each point.

With ground surfaces, the strings defining the ground surface are generally a combination of feature line strings and general lines or contours for regular surfaces. Feature line strings are used for irregular features such as existing roads, embankments, cuttings, edges of creeks, and so on. Contour lines are a special case of a string with only two spatial coordinates for each point, and the contour level as an attribute of the whole string.

With design surfaces, the strings follow some specific feature of the roadway - the centreline, an edge of bitumen, the tops and bottoms of batters, and so on.

Strings may also be used to store cross-sections, although it is generally necessary to have separate sets of strings for the various surfaces in a cross-section, the ground surface, the finished surface and the subgrade surface.

The MOSS program has facilities to store strings as a series of models, each one of which can be thought of as a a three-dimensional picture of some aspect of a project. For example, the ground surface of a project area, or the design surface, or a set of cross-sections, and so on.

The program processing and computations are directed by means of a series of commands which are referred to in MOSS as major options and minor options. The major options specify a particular processing feature of MOSS (eg SURVEY, EDIT, PLOT) and the model, or models, which are to be used as a source of string information, and in which (where appropriate), further string information is to be stored. The minor options control the detail processing within a particular major option.

3. SURVEY PROCESSES IN MOSS

The first step in the development of a road design project is the collection of the survey data describing the topographic and demographic character of the project area. With MOSS, the processes used for survey need to be related to the options available for processing the survey data in the program.

The three options in MOSS for processing survey data are as follows:

DIGIT - Transfer of digitized data from a plan digitizer or photogrammetric digitizer.

SURVEY - Reduction of survey observations.

GENIO Transfer of reduced survey data prepared by other computer programs.

The DIGIT option is commonly used to transfer digitized contour lines prepared using photogrammetric techniques. Old surveys may be digitized using a plan digitizer, while new surveys may be directly digitized during the photogrammetric interpretation. This latter method is used with surveys carried out for MRD WA by the WA Lands & Surveys Department; the data being supplied on a magnetic tape in a format suitable for direct input onto MOSS. One of the important features of MOSS is its ability to make direct use of digitized contour lines as an effective ground model.

The SURVEY option is used where surveys are carried out on the ground. A variety of methods may be used to make the required observations, but the most satisfactory is total-station tacheometry. In all cases the instrument readings are entered on a suitable form, the data is input to the program, and the observed readings transformed into the required three-dimensional coordinates. With total station tacheometry it is also possible to use self-recording attachments and an auxiliary program to generate the input for MOSS without manual intervention.

When ground surveys are made for MOSS it is necessary to use quite different techniques to those used for conventional design systems. Instead of using cross-sections at intervals along a road, the survey must generate strings which follow particular features such as the road centreline, edge of bitumen, fence line, and so on. A positive effort is required by surveyors to change their survey techniques to those which are best suited to MOSS.

After processing the survey data with the SURVEY option, various reporting and display options may be used to check the validity of the survey before it is used for design. One of the most useful techniques is to contour the survey using the CONTOUR option in MOSS. Discrepancies in both position and level tend to show up clearly. Corrections to the ground model are made using the EDIT option in MOSS.

One question which needs to be resolved in using MOSS is whether the validation of the survey data should be carried out by the survey staff or the design-office staff. The MRD WA is developing the practice that it is a proper task for the survey staff; ie the survey task includes the processing of the survey data through to the point where a usable model is handed over to the design office. This differs from past practice where survey books were handed over to the design office for plotting, and requires a transfer of resources into the Survey Section. With the new system, the surveyor carries the full responsibility for the accuracy and completeness of his survey.

Information from MOSS Systems Ltd forecasts the release during 1985 of an interactive EDIT option which will provide the capacity to make corrections to a survey model in an interactive manner from a suitable graphics work station. This should greatly facilitate the survey-validation process.

4. DESIGN PROCESSES IN MOSS

The development of the design of a road-design project makes use of a number of major options in MOSS, of which the most important are as follows:

COPY	Copy strings from one model to another.
EDIT	Create and modify strings using simple geometric relationships.
HALGN	Horizontal Alignment Design. Create master strings (for subsequent development of the design) using circular curves and clothoid-spiral transition curves.

VALGN — Vertical Alignment Design. Add levels to a string using a profile consisting of tangent grades and parabolic vertical curves.

DESIGN — Generate strings which define the various longitudinal features of a road. For example, kerb lines, shoulders, ditches, and so on.

INTERFACE — Generate a string where a batter surface intersects a ground surface.

SECTION — Generate cross-section strings at defined locations by finding all the points at which the section cuts the strings in a particular model.

VOLUME — Find the volumes of cut and fill between two sets of sections; one is typically the ground surface and the other the design surface at earthworks level.

The general design process is the same with MOSS as with more conventional road-design programs, but the detail techniques are quite different. The principal steps required to develop the design of a straightforward section of road are as follows:

(1) Design a master string to define the centreline of the road using the HALGN option. The alignment consists of conventional circular curves and transition curves. The master string consists of a series of points along the alignment, each point comprising the plan coordinates, the chainage, the bearing and the radius.

(2) Develop a longitudinal section through the ground model along the master string from Step (1). This is generally plotted using the PLOT option described in the next article.

(3) Develop a design profile on the centreline using conventional graphical techniques. This profile is then specified to the VALGN option to generate a level at each point on the master string.

(4) Develop a set of subsidiary strings to define the longitudinal features of the road, such as edge of pavement, edge of shoulder, ditch drain, and so on. Each of these strings is defined, using the DESIGN option, as horizontal displacements from the master string (or some other string) and by either vertical displacements or lateral slopes. Provision is made for both constant and variable applications, and therefore allowance may be made for such characteristics as variable-width pavements, curve superelevations, and centreline shift. Although the actual road design may be the same, the techniques used to develop these subsidiary strings are quite different from those used in conventional cross section design - the designer has to think in terms of longitudinal elements rather than in terms of transverse elements. The

subsidiary design strings would normally be set up in two models; one containing all those strings which define the design surface, and the other containing those strings which define the earthworks surface. Some strings need to be in both models.

(5) Develop a set of ground cross-sections using the master string to define the points at which they are to be found.

(6) Develop an interface string on each side of the roadway where a specified batter surface from a particular string, such as the ditch line, intersects the ground surface found in Step (5).

(7) Develop a set of design cross-sections, using the earthworks model, at the same positions as the ground cross sections in Step (5).

(8) Using the VOLUME option, calculate the earthworks volumes between the ground cross-sections and the earthworks cross sections.

(9) Evaluate the design. The various display options described in the next article are used as aids in this process. Longitudinal sections of strings may be plotted; cross-sections may be plotted; the plan layout of batters may be plotted; and so on. The evaluation should result in a decision to accept the design without further change, or to change certain features.

(10) Make changes suggested by the evaluation process and repeat all the above steps as necessary through to the point where a fresh evaluation may be made. Care needs to be exercised to ensure that all changes are properly followed through.

At this stage of its use of the MOSS program, the MRD WA has not yet applied it to a simple design project as above; however, in applying it to a complex freeway project, it was found that there were three aspects where MOSS deserves to be improved. Briefly, these are as follows:

(1) The HALGN option is much less flexible than the alignment design program (ROGO) currently used by MRD WA. It is quite difficult to specify an alignment in terms of particular details already set out on the ground.

(2) The techniques available in the DESIGN option for specifying superelevation transitions do not include the one most commonly used by MRD WA.

(3) There is no provision for the presentation of a mass diagram as an aid to the evaluation of the earthworks.

The modular nature of the MOSS program is such that improvements may be readily incorporated, and MOSS Systems Ltd welcomes specific suggestions.

5. DISPLAY PROCESSES IN MOSS

During the preparation of survey, the development of the design model, and in the presentation of the project for construction, there are various display processes in MOSS which are provided by the following major options:

REPORT Prepare reports describing selected strings in a particular model.

VIEW Prepare perspective drawings of selected models.

PLOT Prepare various plan and section drawings.

The REPORT option is generally used to provide a printed list of the individual points in selected strings in a model. Options are also available to detail the bearing, distances and slopes between successive points and to detail the relationships between two strings. These reports are commonly used to check the progress of model generation, although in many cases the PLOT option is preferred.

The VIEW option is used to produce perspective drawings. One of the important applications here, although it has yet to be explored by MRD WA, is to superimpose a perspective drawing on top of an oblique aerial photograph to give a representation of the completed project. This type of picture can be very useful in presenting a proposal to Councils, Government Agencies, and the general public.

The PLOT option is the most important display process provided by MOSS. It has a wide variety of options available in it to control the nature, extent and detail content of drawings; and can be used with a variety of display and plotting devices for the presentation of these drawings to the user.

In the MOSS system as implemented by MRD WA, each drawing specified generates a picture file which is stored in the system until the user executes a separate display program which may:

(1) Display the drawing on a CRT screen, or

(2) Generate a plot tape for the production of the drawing on a Calcomp drum plotter.

The CRT display program is most generally used during the development of a design to check the progress of the design. As the design is built up, various bits of it are drawn, and displayed on the screen, to ensure that they bear the proper relationship to one another and to provide a basis for further development of the design. At various stages it is also appropriate to produce actual drawings using the drum plotter.

With drawings produced for checking the development of the design, it is essential to provide a rapid response. The CRT display can do this, but at the expense of clarity. The ideal system would be one which would provide a full-scale drawing on demand - such systems are available, but they are rather costly.

Once the design is complete, the PLOT option may also be used to prepare construction drawings. Some manipulation is necessary to arrange suitable drawings, and the user must be prepared to accept some changes to accepted methods of presentation. With these qualifications, MOSS may be used to produce most of the drawings required for construction.

6. INTEGRATION WITH OTHER PROGRAMS

One of the features of MOSS which has had a bearing on its use by MRD WA is its ability to be integrated with other road-design programs. This arises from the provision of the GENIO major option for the specific purpose of transferring information to and from other programs. Some of the facilities in GENIO are directed towards particular computer programs available in the UK, but others are more general in nature.

The MRD WA makes use of the GENIO option for three specific interface functions with other programs as follows:

(1) Input from its interactive survey program.

(2) Transfer of string information generated by its road geometry program (ROGO).

(3) Transfer of cross-sections to its earthworks and road-design program (IRDES).

By making use of MOSS in this fashion, we believe that we have been able to optimize the characteristics of our total road-design system; preserving the best features of our existing systems and using MOSS where new features were required.

7. MOSS AND CADAD

CADAD (Computer-Aided Design and Drafting) is an area of growing development. Engineering authorities are using it as a means of improving production and improving the quality of designs. In general terms a CADAD system requires a graphics-oriented computer workstation which is used in lieu of a drawing board for the development of designs and the preparation of drawings. CADAD systems currently available have the potential for application in the road-design area, but there are very very few actual application programs available.

Although MOSS is lacking in interactive features at the present time, it is understood that development work is currently in hand in this area. The interactive EDIT option has already been referred to, and substantial improvements to plotting facilities are also forecast for release in 1985.

It is my belief that the development of interactive CADAD features in an existing road-design system such as MOSS has much greater promise than developments which seek to add road-design features into existing CADAD systems.

8. MOSS FOR LOCAL GOVERNMENT AUTHORITIES

Having described in broad terms the use of MOSS by MRD WA, it is now appropriate to look at the possible use of MOSS by Local Government Authorities.

Firstly, it is necessary to say that the use of MOSS would require a deep commitment to computer-aided design. It would require changes to traditional methods of survey (both pick up and set-out), changes to traditional methods of design, and changes to methods of presentation. It should not be entered into lightly, but in the belief that better designs will provide safer roads with reduced construction costs.

With this in mind, there are four characteristics of MOSS which are considered relevant to its selection as a computer program for computer-aided design of roads:

(1) Its comprehensive character. MOSS covers the whole field of survey, design and presentation of drawings in a single program.

(2) Its availability and support. MOSS is available on a variety of computer systems and it is supported by an Australian Agent based in Melbourne. The Agent's staff includes engineers who have used MOSS for road design.

(3) Its adaptability to work with other programs. The user can retain features of existing systems and work them in conjunction with MOSS.

(4) Its prospects for enhancements. MOSS is a 'living' program which is being continually enhanced. Feedback from users is encouraged.