AUTOMATIC STRUCTURAL DATA GENERATION FOR OFFSHORE PLATFORMS

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SUMMARY

GADEP is a computational system for data generation and for graphic treatment of analysis results, concerning the structures of offshore platforms. This system operates on an advanced CAD/CAE unit and has efficient interfaces with the ADEP system, for structural analysis and design, and with the GEDEP system, for the generation of platform and production facilities technical and fabrication drafts. Thus, those three systems provide the necessary tools for fully automated offshore structure design.

This paper discusses the fundamental aspects taken into account in the design and implementation of the GADEP system. An illustrative example is also presented, in order to show a practical application of the system.

INTRODUCTION

The computational systems currently available for structural analysis, make possible the treatment of numerical models having several thousands of degrees of freedom, which is usually the case with the analysis models for offshore platorms. These models imply the preparation of a large volume of data. This task is not only time consuming, but is also a source of errors, problems which can be avoided or minimized using automatic data generation.

Many modern computational systems have commands or facilities having the objective of reducing the user

effort in the structural definition, using methods such as super-elements, generation by symetry, generation by similarities, etc. However, a procedure for the generation of data corresponding to specific space frame problems (1), can achieve a greater efficiency than a general procedure for the generation of finite element meshes(2).

The **ADEP** system, for analysis and design of offshore structures, implemented by Petrobrás S.A., has two especific subsystems for data generation. One of them comprises a collection of user oriented commands for the complete definition of the structure of fixed offshore platforms, including the jacket, the piles, and the conductors (3). The other is oriented to the automatic generation of finite element meshes for analysis of tubular joints. The **GADEP** system has similar objectives as the first one, but introduces a higher level of sophistication and efficiency, as it operates interactively on a graphic terminal both for data generation and for graphic treatment of analysis results.

GADEP is implemeted on a Intergraph CAD/CAE unit installed in the research center of Petrobrás, which operates on a VAX 11/751 computer, having 4 megabyte memory, two disk units, a HP7585B plotter, a V80 hard copy and 4 dual colour graphic terminals. The system is fully coded in FORTRAN 77, with the utilization of DMRS, Data Management and Retrieval System (4, 5), and IGDS, Interactive Graphics Design System (6) to treat graphic files.

BASIC FACILITIES

The **GADEP** system was specifically designed to fulfill the following objectives:

- Easy and flexible use
- Compability with existing Petrobras systems
- Total automatization of the design of fixed steel offshore structures

In order to achieve the first objective the following techniques were applied:

- Intensive use of tutorials, displaying an adequate degree of information consistent with the degree of complexity of the data to be input by the user.

- **Flexible implementation offering several alternative options to define a given structure.**
- **Visual response to each user operation.**
- **Visual information control, including the possibility of separate visualization of different parts of the structure, or of different information for each part or the whole structure.**

The compatibility with the existing Petrobras systems is achieved by means of efficient interfaces, particularly between the **ADEP** and the **GADEP** system. A structure, of part of it, can be generated using the **ADEP** system, and can be altered or completed by the **GADEP** system, using computer graphic techniques,. The inverse operation is also possible. On the other hand, the final fabrication drafts are produced by the **GEDEP** system, accessing the **GADEP** data base.

The total automatization of the design procedure for fixed offshore structures is possible in particular due to the use of a unique data base, containing all data necessary both for analysis and design on the one hand, and for drafting on the other.

The graphic data corresponding to a structural model are composed by lines and solids, representing the member elements, circles, representing the nodes, and texts, for member and node identification, which are stored in a graphic file connected to the data base. This also contains data regarding materials, member geometric properties, boundary conditions, and loadings.

OPERATION

GADEP operates from a graphic station. The flow of input data is decided by the user, by selecting options from the tutorials. The Intergraph basic commands, together with general commands implemented by Petrobras are activated from the table. As soon as the **GADEP** system is called the tutorial shown in the upper left part of Figure 1 is displayed.

The selection of an option from a tutorial is made by means of a cursor which can be displaced over the tablet, causing corresponding displacements of small cursor on the scope. Alphanumeric data is specified on the terminal keyboard.

The selection of options on the main tutorial leads to the appropiate tutorials, which can lead to others, establishing a tutorial sequence, which is assembled from the user requests. For instance, Figure 1 shows the tutorials used for the generation of nodal points and members, and for the specific generation of members of type 3.

Since the fixed steel offshore structures usually have the form of a pyramid sector with rectangular base, the data regarding the jacket legs can be easily generated by indicating the leg locations at the base, the batters and the elevations, as shown in Figure 2.

The panels which form the jacket faces and the horizontal bracings, together with the conductor guides, can be easily generated making use of the options provided by the panel tutorials, which include a dictionary of panel types.

The system also allows for easy updating of the structural data not only for geometry and connectivity, but also for properties, loadings, support data, etc. It is also possible to generate data by symmetry operations, or by performing translations, rotations, etc.

In order to control the information specified by the user and that automatically generated, up to 15 different levels can be used for the graphical information. The texts, in particular, are placed in levels different from the members and joints.

The data generated by **GADEP** can be sent to IBM and CDC computers, for processing by **ADEP**, and the results can than be brought back in order to display deformed shapes, natural modes, forces and moment diagrams, etc.

The example presented in what follows corresponds to the generation of the data of the analysis model of a 30 m. high platform. The isometric view of the model is whown in Figure 8. Figures 3 to 7 are exact reproduction of the scope, during the generation process, divided in 4 parts, each of which can show different parts of the graphic file, or a tutorial.

Figure 3 show the scope at a stage where the basic part of the model has been already generated. The upper left part contains the tutorial used to generate that basic part, while the upper right part

contains the isometric view, the lower left part the plan view and the lower right part the lateral left view.

Figure 4 shows the generation of the panel for the upper horizontal level, including the tutorial used. Figure 5 shows that generation already completed. The tutorial displayed shows that the user can select among other things the dimensional units to be employed. The table of tubes is also shown. Data to be specified include the names of the tubes and the distances between the nodes. Tha information can also be altered by a cursor selection followed the input of the new information on the station keyboard.

The complete model is whown in Figure 6. Figure 7 illustrates three different views of a detail of the model, and the tutorial used to generate the nodes.

Finally, Figure 8 shows the isometric view of the complete model, including the real representation of the tubes using solid modelling and elimination of hidden lines. Figure 9 shows the deformation of the structure under a loading composed by wave action, dead weight and buoyancy.

CONCLUSIONS

The GADEP system provides an alternative for definition of data for offshore structure analysis models having the following advantages:

- Large reduction of the time required for data preparation and for the production of fabrication drafts.
- Minimization of coding errors .
- Easy production of alternative designs.
- Easy updating of the model data.
- Possibility of total automatization of the structural design, with the support of the ADEP and GEDEP systems.

REFERENCES

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Three-Dimensional Framed Struc.", Computers & Structures, Vol. 17, No. 1, 1983.

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5. Intergraph Co., "VAX DMRS Data Definition Language User's Guide ", Huntsville, Alabamma, 1983.

6. Intergraph Co., "IGDS Appl. Software Interface Document", Huntsville, Alabama, 1983.

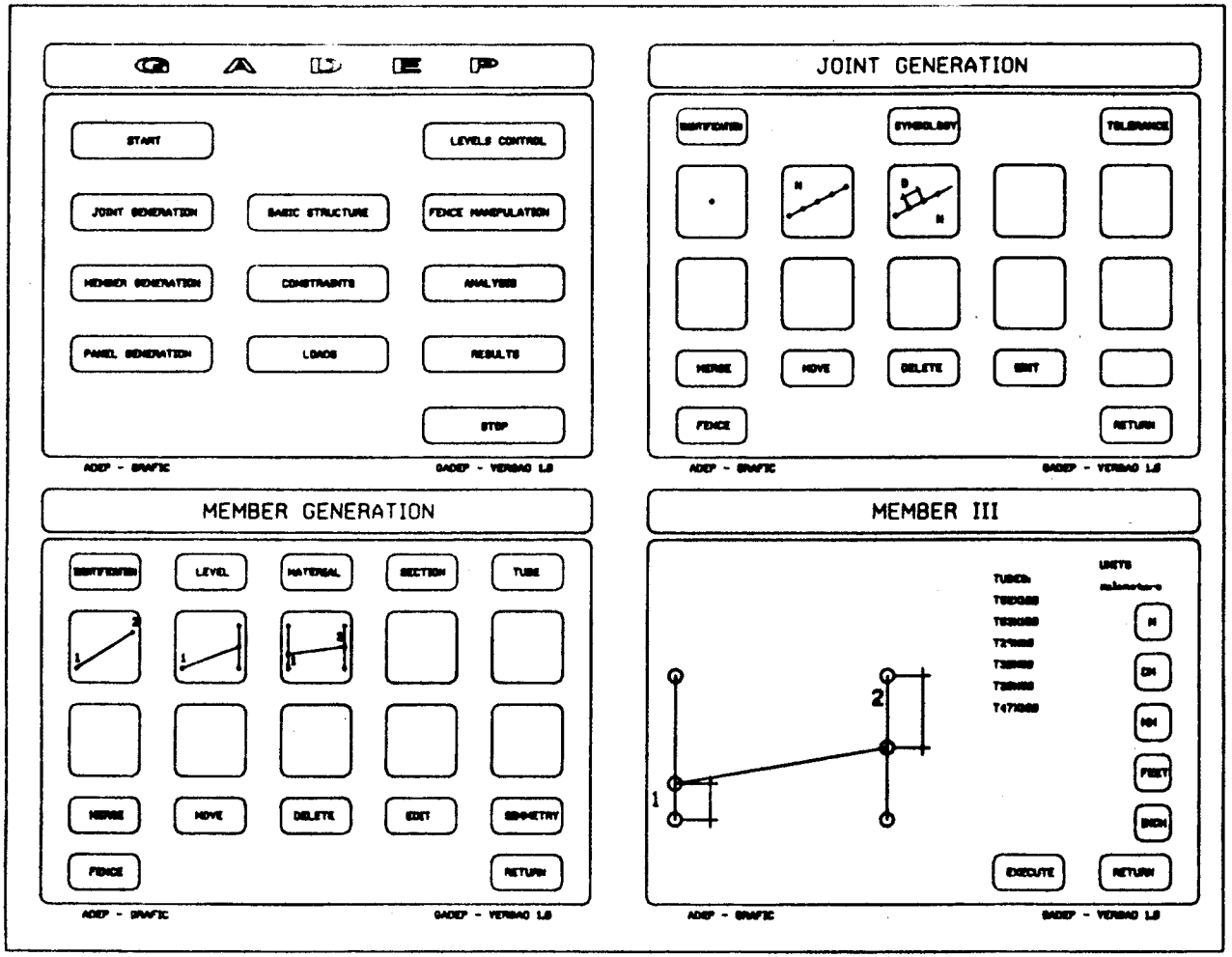

FIGURE 1 - Main, Joint and Member Generation Tutorials

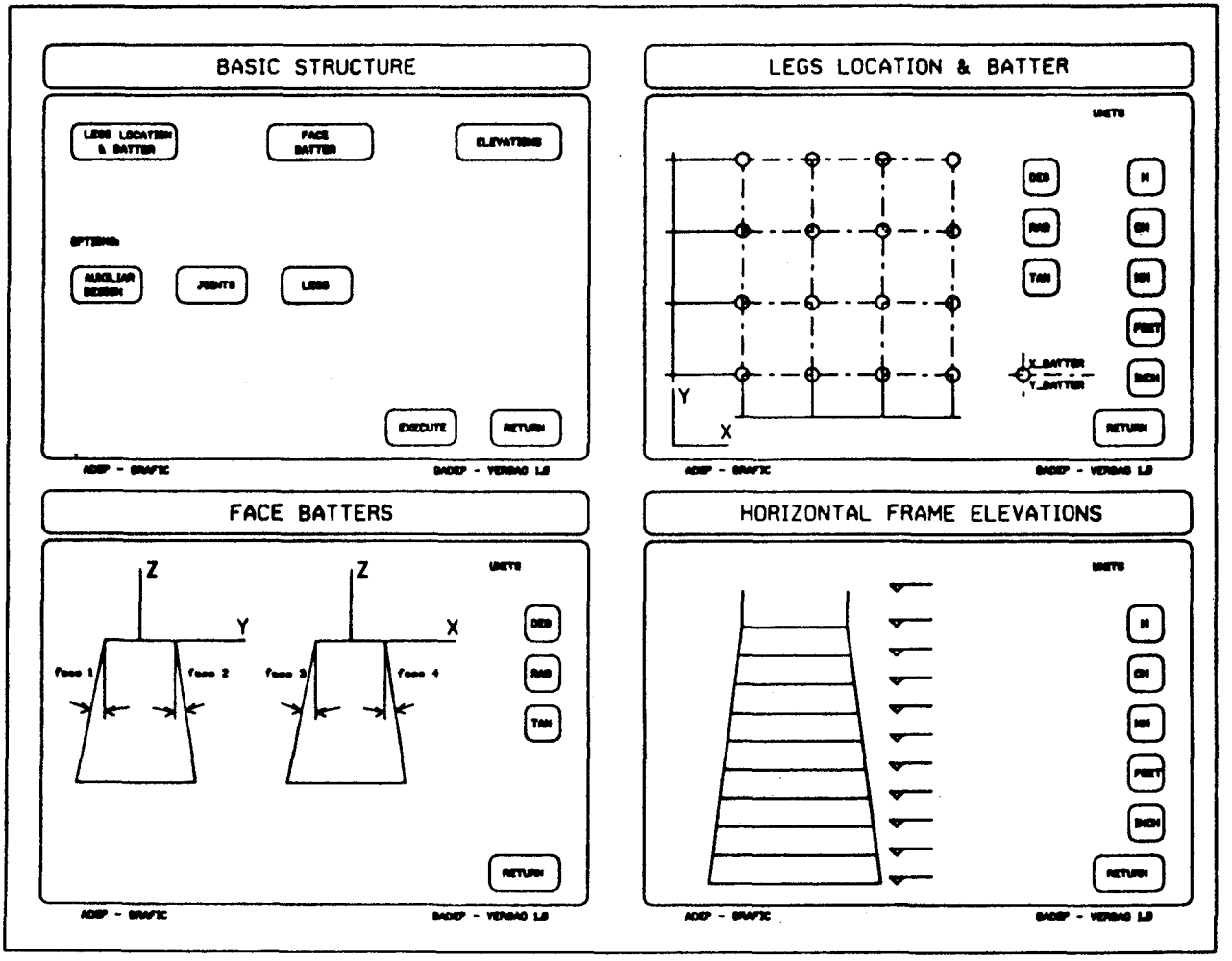

FIGURE 2 - Basic Structure Generation Tutorials

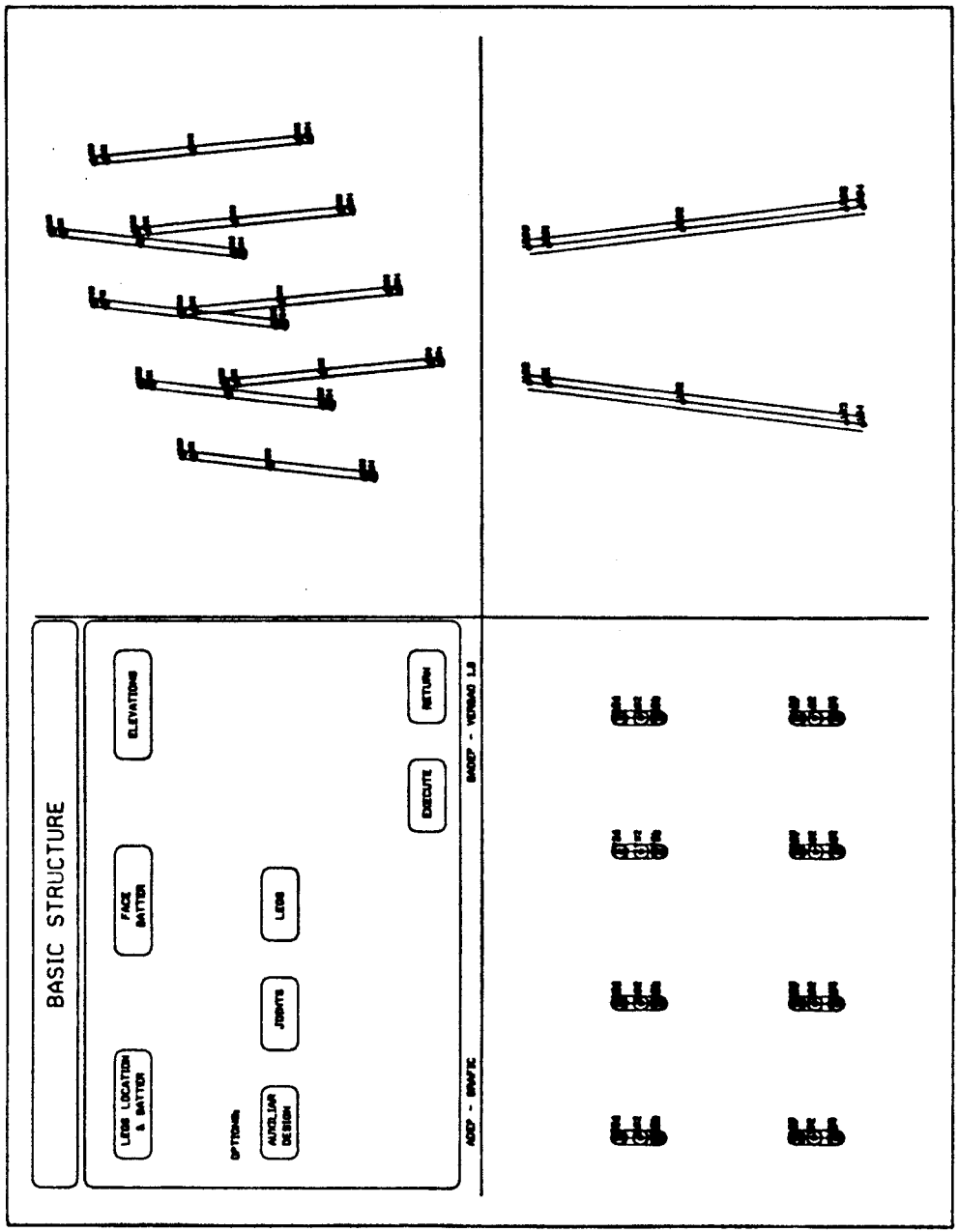

FIGURE 3 - Basic Structure

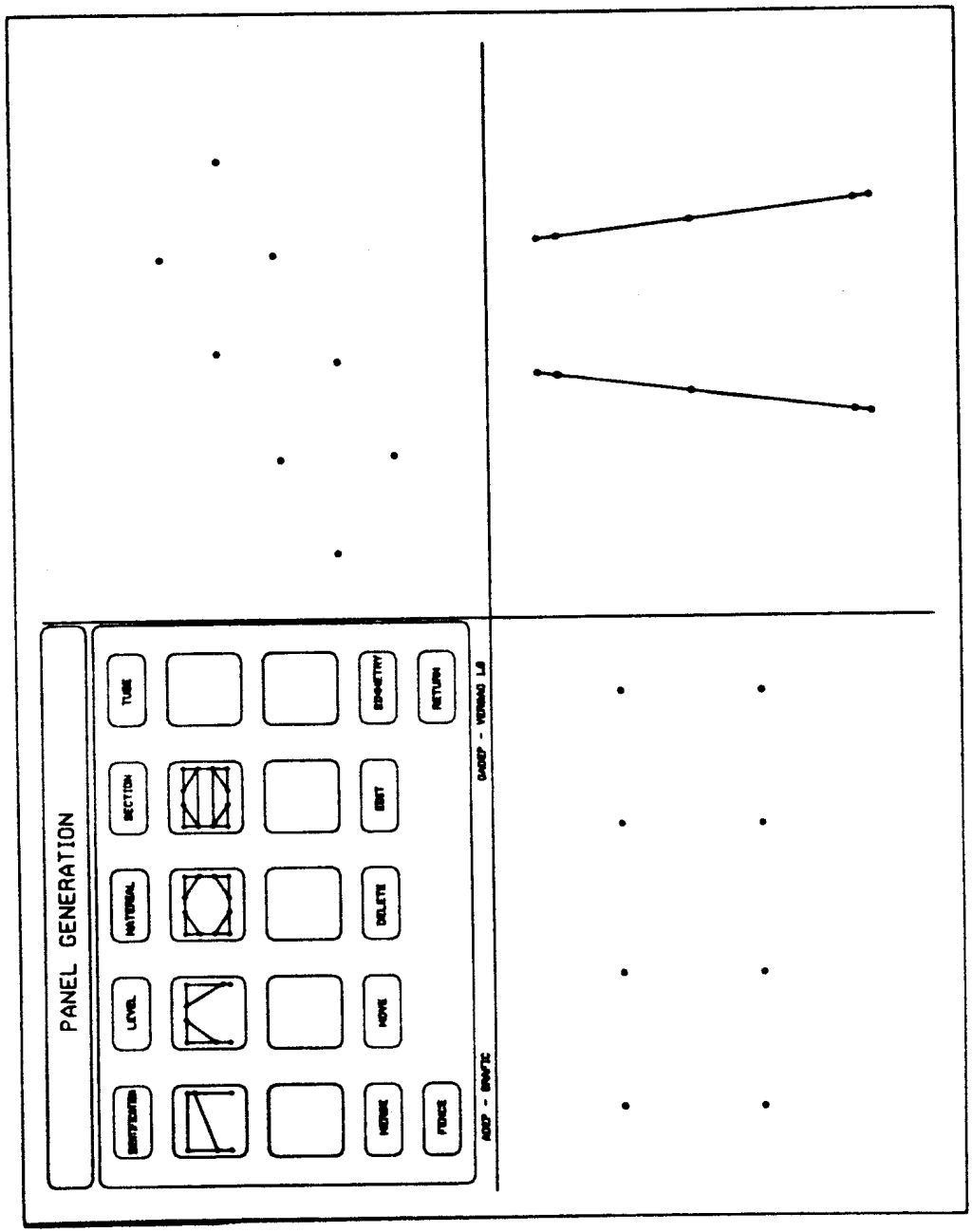

FIGURE 4 - Start of First Panel Generation

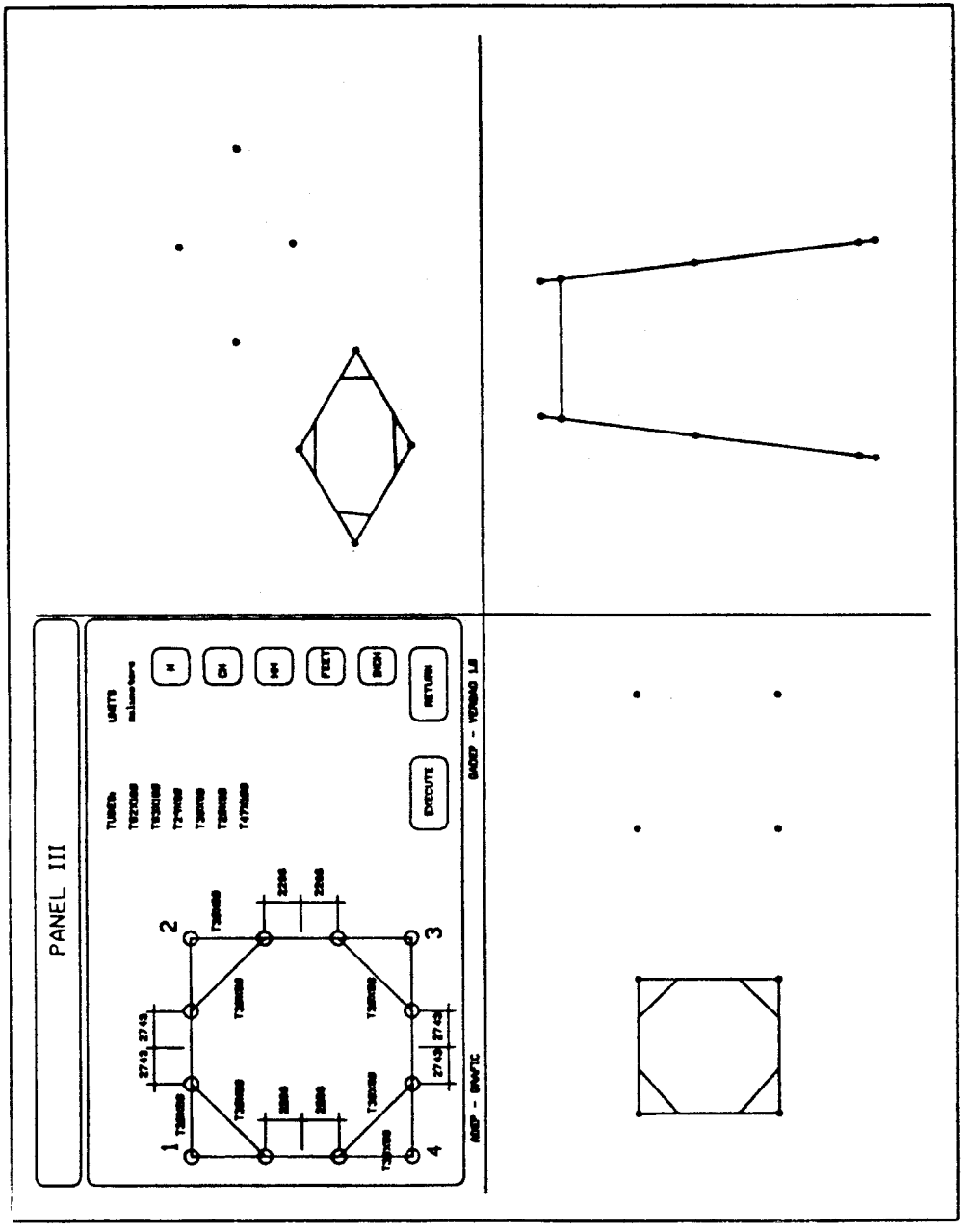

FIGURE 5 - First Panel Generation

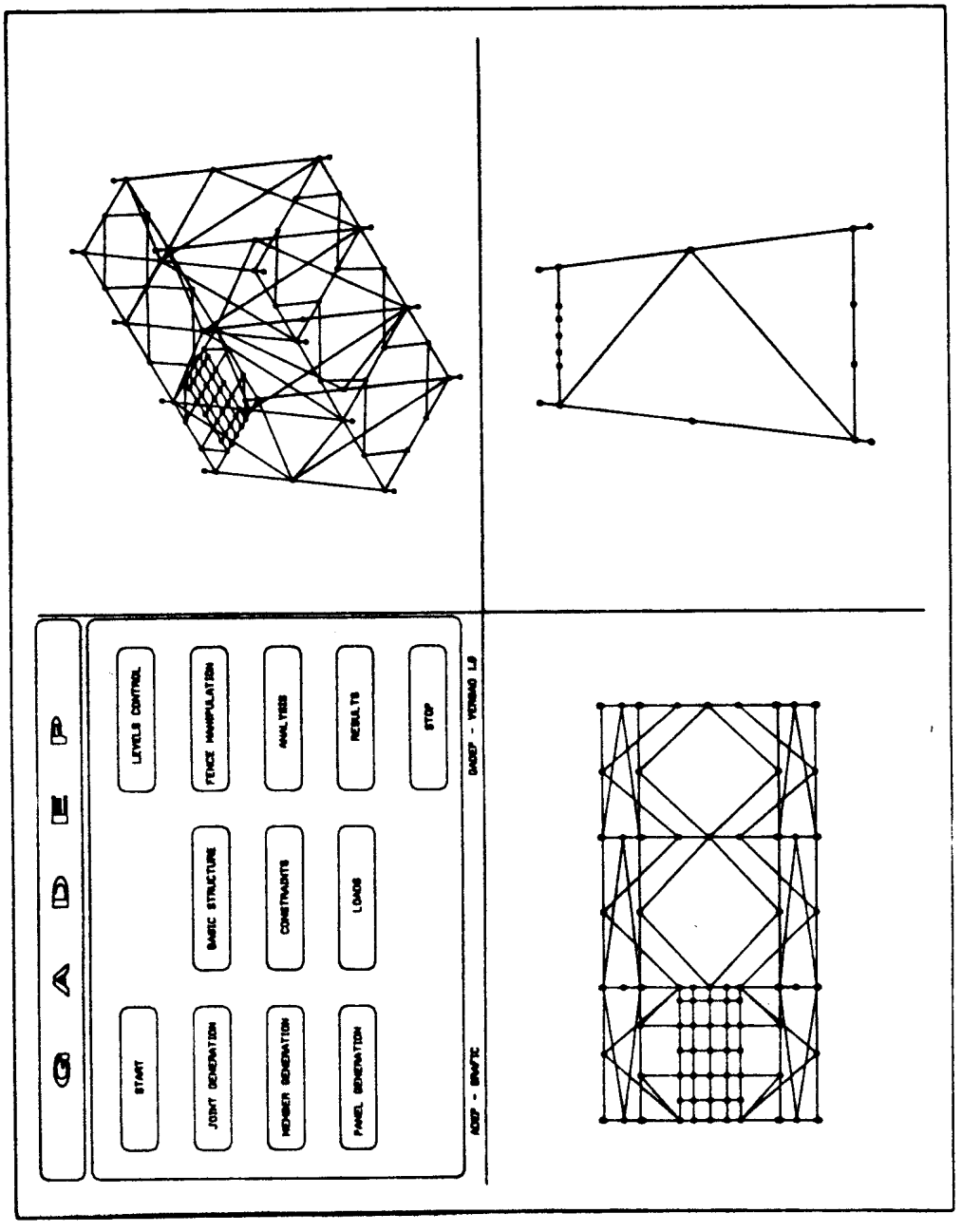

FIGURE 6 - Main Tutorial and Complete Structure

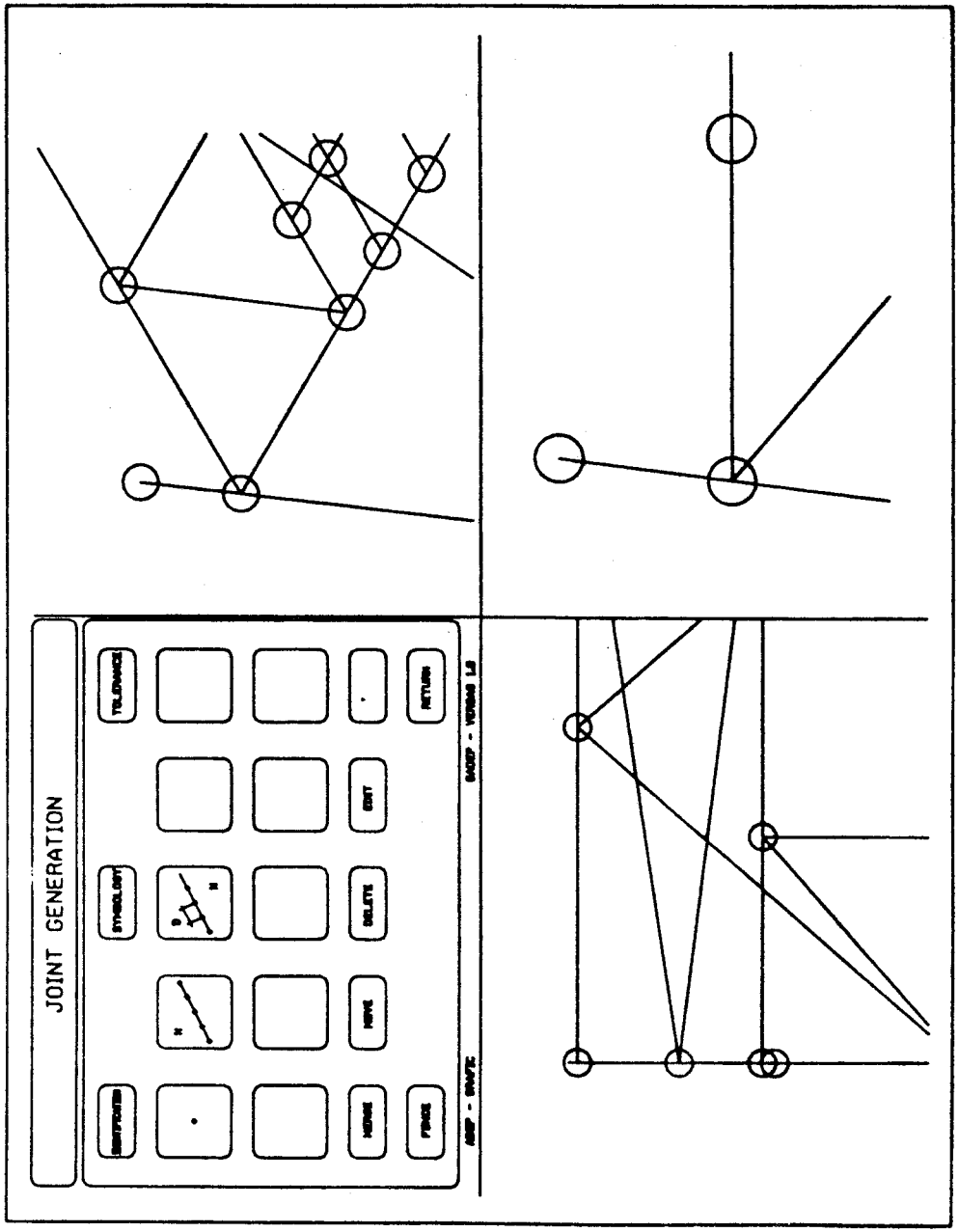

FIGURE 7 - Structure Detail and Joint Generation Tutorial

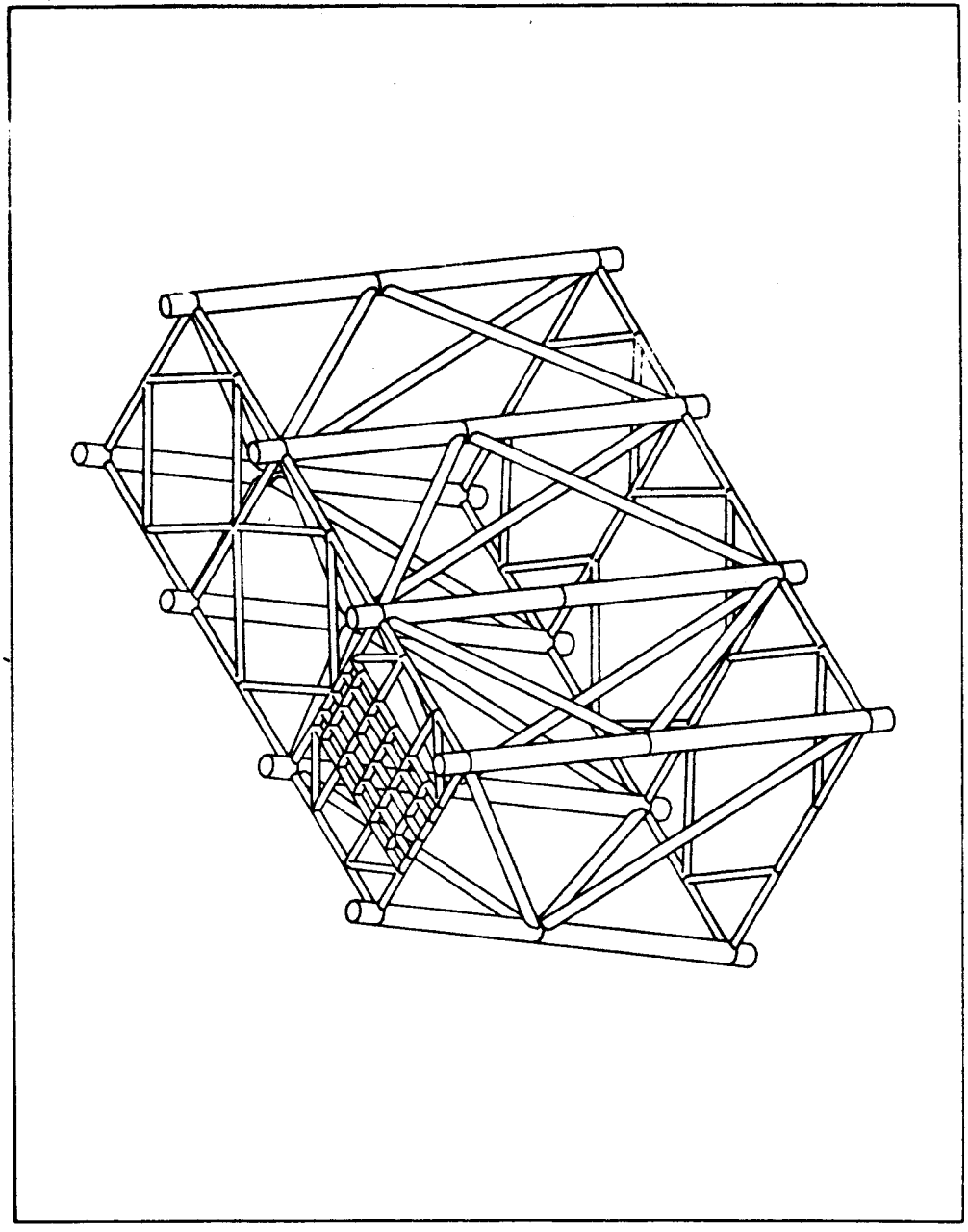

FIGURE 8 - Isometric view

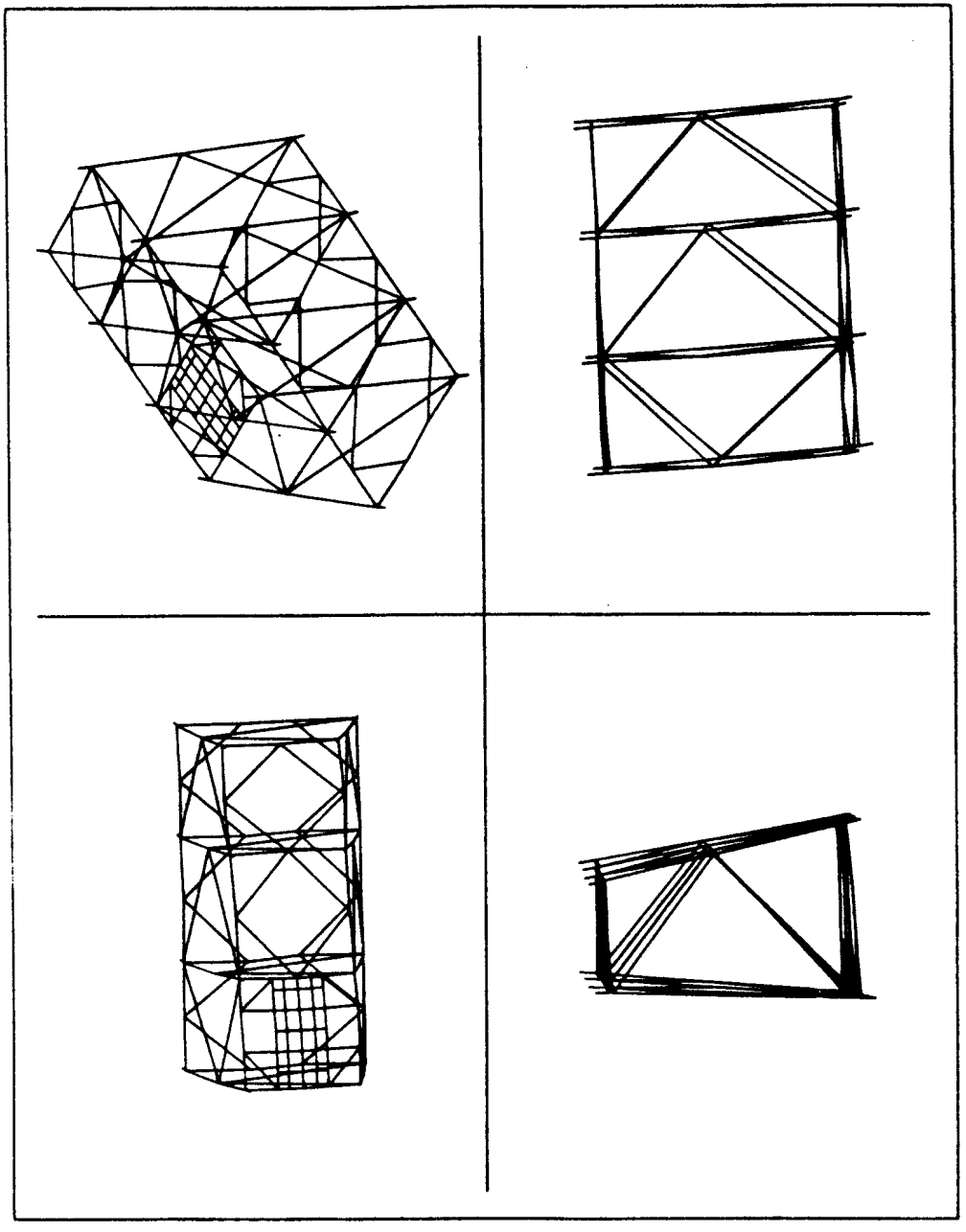

FIGURE 9 - Views of Deformation of Structure