VLT Systems Engineering Group Moving Ahead

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Large projects require participation of many specialists working in different fields. Though highly capable, it is not possible for each of these specialists to have a complete overview of the project. Hence, in large projects like the VLT, there is a trend towards installing a separate systems engineering group to assist the programmme manager in keeping a technical overview.

The task of systems engineering for the VLT was initially performed by staff of the Telescope Department. However, to further strengthen the organisation of the VLT, a separate Systems Engineering Group was set up at the beginning of 1995. At present, the group has five members that are all specialised in system analysis or synthesis.

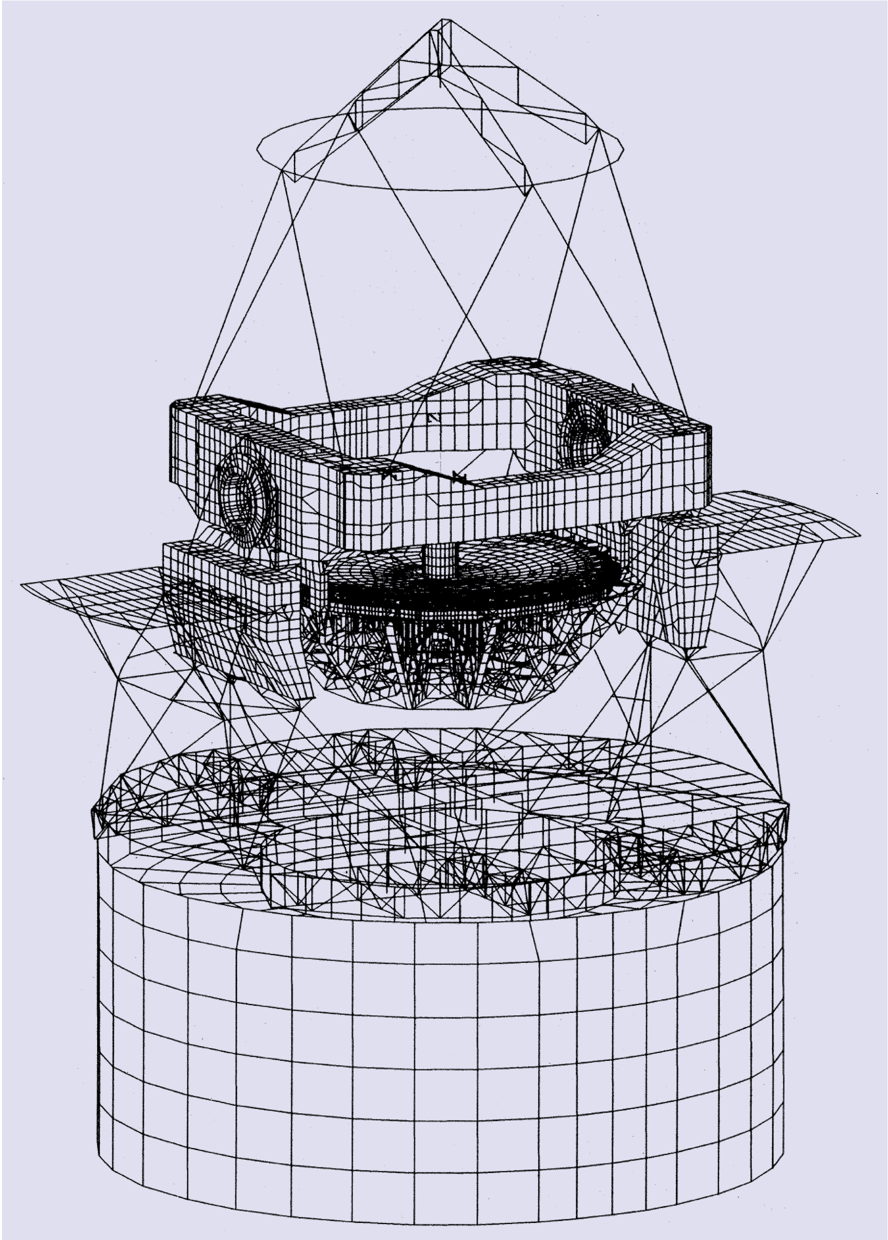

Figure 1. Finite-element model of a unit telescope of the VLT. The model has over 100,000 degrees of freedom.

Finite Element Computations

Execution of finite-element calculations is one important working field of the group. Many VLT contractors carry out calculations of this nature for subsystems. However, to ensure correct modelling, it is necessary to supply simplified computer models of the interfacing structure. It is also necessary to combine models from subcontractors to ensure that the performance of the complete telescope will be satisfactory.

Such combined models tend to become large with many thousands of degrees of freedom. Hence, it is often required to reduce model size by applying superelements or condensation techniques. Figure 1 shows a finite element model of the complete telescope. The model is based on various submodels received from contractors.

The model has over 100 000 degrees of freedom. Since it is a formidable task to solve 100 000 equations, reduction techniques have been applied to reduce

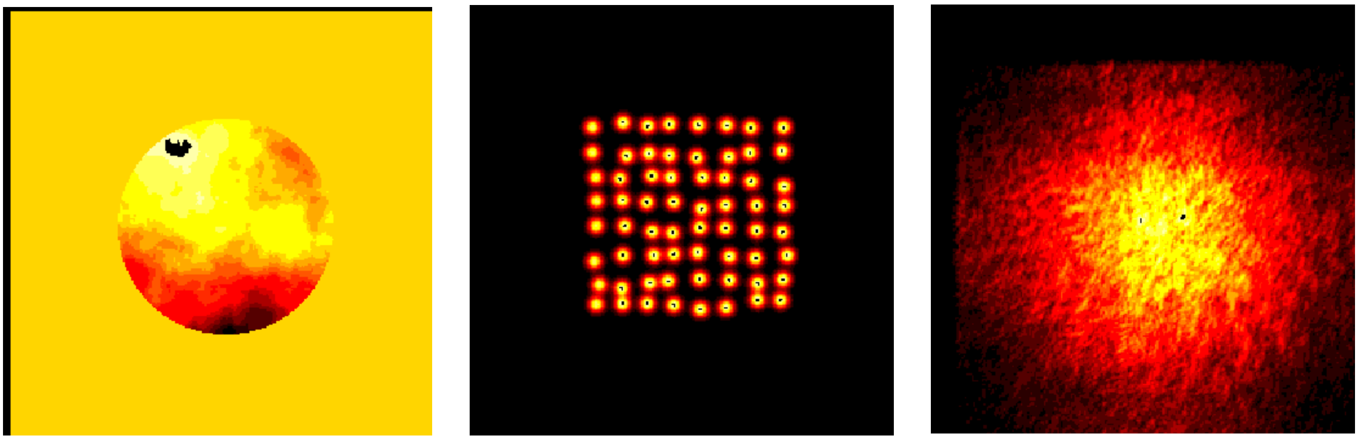

Figure 2. Atmospheric phase screen (left), Shack-Hartmann pattern in wavefront sensor (middle), and final star image (right).

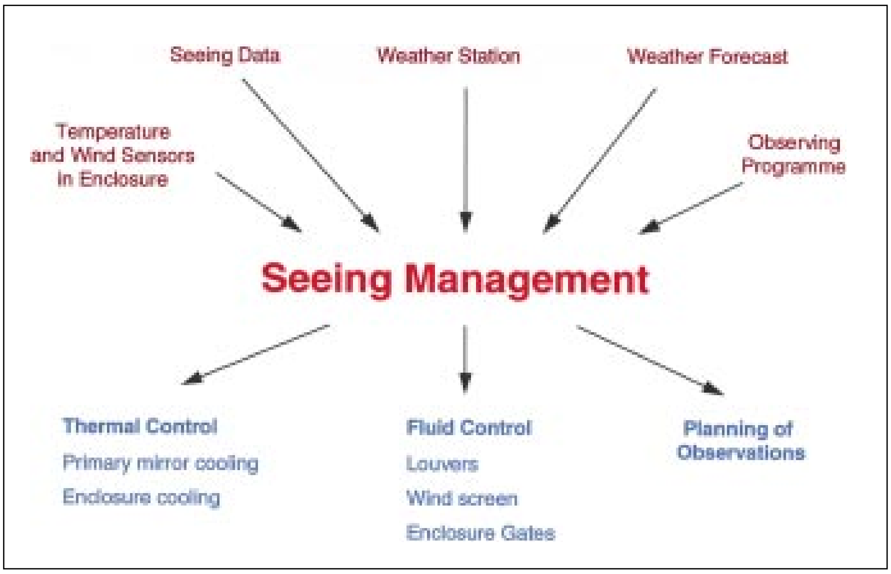

Figure 3. The philosophy of seeing management for the VLT.

the number of degrees of freedom to about 40,000 before solving the equations.

Simulation Models

It is essential to be able to predict accurately the VLT performance, and to study the effect of changes or malfunctions. To achieve this, a simulation model including optics, structural dynamics, mirror support system, atmosphere, detectors, and active optics has been set up. The computer model simulates telescope performance in the time domain.

The simulation model has been applied to study a number of different effects, in particular those related to performance of the active optics system under wind load. Some representative results are shown in Figure 2.

Currently, a simulation model of the VLT Interferometer system is being developed. The model will include optics, disturbances from atmosphere and tunnel turbulence, star characteristics, detector dynamics, fringe sensor, control loops and structural dynamics. The model should be ready in about one year. Ultimately, it will interface to a scientific module that will permit evaluation of VLTI scientific performance.

Seeing Management

Although seeing can normally not be controlled freely, it can be strongly influenced by a proper thermal and fluid dynamical control. A diagram depicting the seeing management philosophy is shown in Figure 3.

A thermal computer model of the VLT has been set up to study possible control strategies. Also, a strategy for establishing optimal cooling of the telescope and primary mirror has been established. Currently, implementation of the model in the VLT control system is in preparation.

A strategy for the control of the wind screen, louvers, and hatches has been formulated. For different wind speeds and pointing angles with respect to wind, a decision table has been derived. This is illustrated in Figure 4, showing the settings of wind screen, louvers and hatches for different situations.

Configuration Control

A large number of documents and drawings have been issued for the VLT. During design, manufacture and installation of the telescopes it is inevitable that changes or corrections are introduced. To assist in contract management and to preserve integrity in the documentation material, configuration control must be performed at an appropriate level.

Procedures have been set up for the handling of changes and waivers. Further, support related to failure reports is given to the Quality Assurance manager.

Not least due to the great distance between Paranal and Garching, it was found essential to establish a computerised tool for configuration control. The functionality of this tool has recently been specified and suitable ways of implementation are being studied. It is the intention to have a first version of the tool in place before testing of the first telescope in Milano. Besides the tasks dealt with above, it would provide for electronic problem reporting and a daily log book. Access via the Web is foreseen for authorised users.

Finally, complete drawing libraries will be set up both on Paranal and in Garching.

Integration and Commissioning

Systems engineering has participated actively in the planning of integration and commissioning on Paranal. Systems engineering will participate in these activities and will provide a link between the engineering groups in Garching and Paranal.

Other Activities

Systems engineering is giving support to various teams at ESO related to

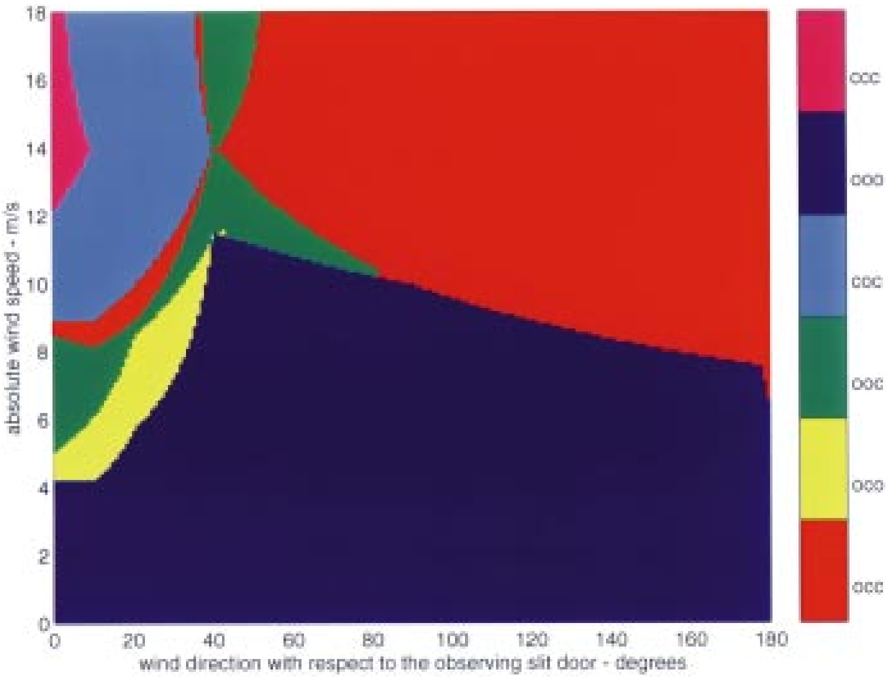

Figure 4. Diagram showing setting of ventilation doors, louvers, and wind screen as a function of angle to wind and wind speed. Letter code: First character=ventilation doors, second character=louvers, third character=wind screen. O=open, C=closed.

engineering activities in the definition phase, or modifications and upgrades to existing systems. One example is a possible implementation of a nutating subreflector for the SEST. Development of such a facility is presently contracted to a subcontractor.

Conclusion

VLT Systems Engineering has now been fully set up and is in operation. It is expected that VLT Systems Engineering will play an important role during commissioning. Finally, Systems Engineering is seen as the nucleus for possible new large projects of ESO.

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KODAK Technical Pan 4415 Film at the ESO Schmidt Telescope

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For the past 25 years the ESO Schmidt telescope has operated with photographic plates, first using the IIa emulsions, and later the finer-grained IIIaJ and IIIaF emulsions. For a number of reasons, we have now discontinued the use of emulsions on glass plates and have changed to a new film-based emulsion. Firstly, prices for our large 30 cm × 30 cm plates have been increasing in recent years, and are now close to 100 US dollars per plate. Secondly, Kodak has for extended periods had difficulties delivering plates, and the continued production of large glass plates has been in doubt. Finally, and most importantly, reports from the United Kingdom Schmidt Telescope Unit on the astronomical use of Kodak's Tech-Pan 4415 film have been very positive. Consequently, one of our plateholders has been redesigned at La Silla for the use of film, and we are now in the final stages of an extended period of testing this new system.

Kodak Tech-Pan 4415 film is a black-and-white panchromatic negative film with extended red sensitivity. It has a fairly uniform spectral sensitivity at all visible wavelengths, and extends out to 690 nm, which makes it particularly useful for work at Hα. In fact, solar astronomers doing Hα photographs of the surface of the Sun were the first to exploit this emulsion for astronomical purposes. Night time astronomical use of the 4415 emulsion was pioneered by amateur astronomers, and it remained exclusively in amateur use until the UKSTU undertook a major study of its astronomical applications a few years ago (e.g. Parker et al., 1994). The film is extremely fine grained, with grains of about half the size of the IIIa emulsions, allowing much higher resolution. The sensitivity is very high for a photographic emulsion, and a DQE of 4–5% has been estimated for hypered emulsions.

As for most photographic emulsions, the best results for astronomical purposes with the 4415 emulsion are achieved when it is hypered. Tests at La Silla have shown that optimum results are achieved when the film is baked at 70°C and soaked in a flow of Nitrogen for 30 minutes followed by Hydrogen for 6 hours. After exposure the film is developed in D19 at 20°C for 8 minutes.

Glass plates have the advantage that they are stiff, and our plateholders have employed a simple mechanical pressure along the edges of the plates to bend them to the shape of the precisely machined mandrel. A similar method will not work for a film, so Wolfgang Eckert designed at La Silla a set of fine interconnected grooves in the mandrel, which, when connected to a vacuum

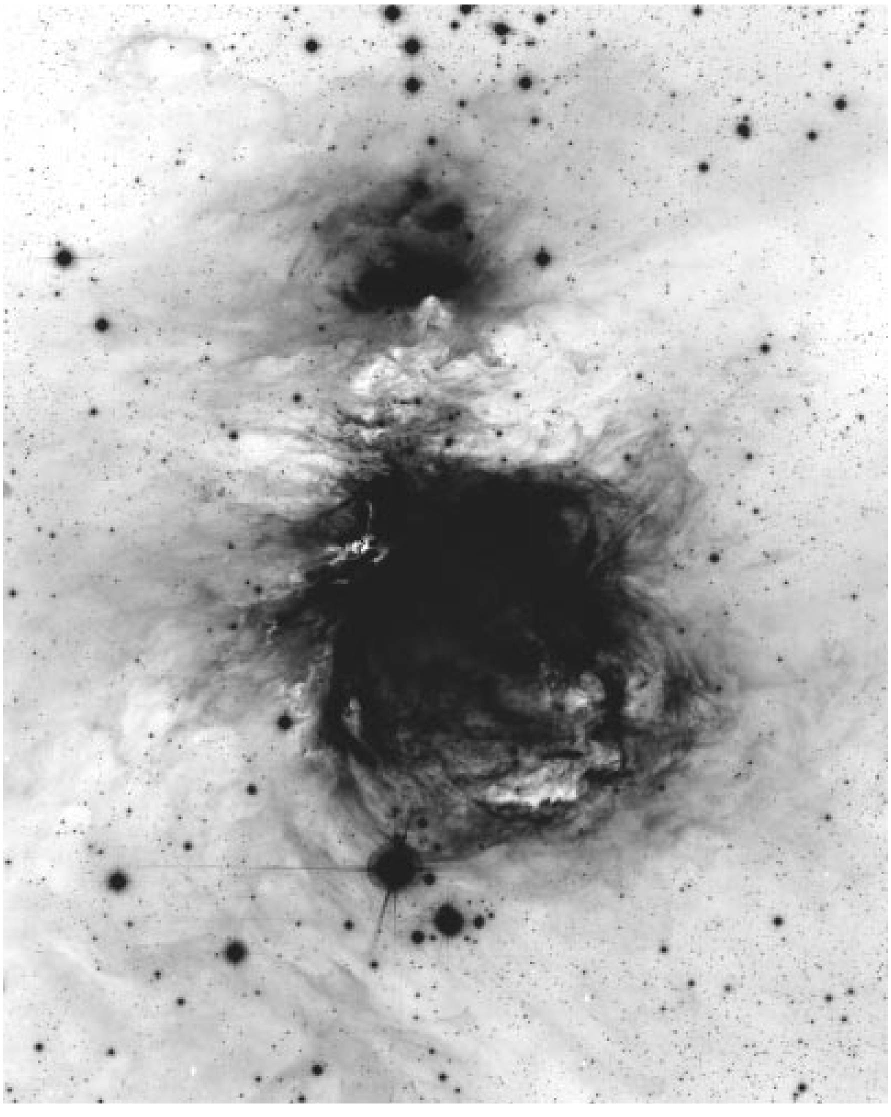

Figure 1: Part of an ESO Schmidt exposure of 150 minutes duration using the new Kodak Tech-Pan 4415 film-based emulsion and an RG 630 filter, showing the Orion Nebula.