Status of the European ELT

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In December 2004 the ESO Council defined as ESO's highest priority strategic goal the retention of European astronomical leadership and excellence into the era of ELTs, asking that the construction of an ELT on a competitive time scale be addressed by radical strategic planning. Therefore the ESO activities towards the future European ELT underwent a major 'phase transition' during 2005, with the completion of the exploration of the OWL concept and its comprehensive review by an international panel, followed by the start, with an extensive ESO Community involvement, of the iterative process that should lead quickly to the definition of the ELT it needs and wants.

The OWL conceptual study

Since 1998 ESO has been pursuing a conceptual study for a giant optical-infrared telescope with a primary mirror diameter D up to 100 metre, dubbed OWL for the eponymous bird keen night vision and for being OverWhelmingly Large. What started at first as a low-key evaluation of the main promises and challenges associated with such a daring endeavour picked up considerable momentum over the last four years. Following the December 2004 Council resolution, it was decided to complete rapidly the study and proceed to a thorough review by an international panel by the end of 2005.

The OWL Study has largely been an ESO internal effort, but with essential feedback from industry and with community involvement in two critical areas. The first of these was the building over the last five years of a thorough science case for a 50–100-m ELT by a large segment of the community under the aegis of the European Commission (EC) FP5 and FP6 OPTICON programme (see its executive summary at: *http://www.astro-opticon.org/*). The second was the preliminary definition and analysis of a potential OWL instrument suite that could cover its science case, and which has been accomplished over the last 12 months through an ESO-coordinated intense community effort.

Construction of any ELT – especially if up to 100-m diameter – requires securing new enabling technologies through an extensive R&D programme. Early collaboration with industry has led to much progress in a number of crucial telescope design areas such as serial production of (spherical) mirror segments either in glass or SiC, cheap yet high performance position actuators, large deformable mirrors, etc. These developments give a strong basis to break the classical (and potentially lethal) $D^{2.6}$ cost law. A much more shallow law (~ $D^{1.4}$) has been established instead, owing in particular to serial production of identical mirror segments, standardised mechanical parts and actuators. The launch four years ago of second-generation VLT instruments has led to the development, largely by the ESO community, of a number of ELT 'pathfinders', in particular KMOS, Planet Finder, MUSE and the VLT Adaptive Optics (AO) Facility (for more information, see *http://www.eso.org/instruments/* and *http://www.eso.org/projects/aot/*). A significant part of the R&D associated with this effort is being conducted through OPTICON.

The OWL review

The OWL Conceptual Study was completed and its results collated in early October 2005 in the 'Blue Book' report (*http://www.eso.org/projects/owl/Phase_A_Review.html*). A comprehensive review was conducted by an international panel on 2–5 November 2005. Members were: Roger Davies, Oxford University (Chair); Jean-Gabriel Cuby, LAM-Marseille; Brent Ellerbroek, Thirty-Metre Telescope Project Office; Daniel Enard, formerly VIRGO; Reinhard Genzel, MPE-Garching; Jim Oschmann, Ball Aerospace; Roberto Ragazzoni, INAF-Arcetri; Larry Ramsay, Hobby-Eberly Telescope; Stephen Shectman, Carnegie Observatories; and Larry Stepp, Thirty-Metre Telescope Project Office.

The first objective of the review was to assess whether, or to what extent, the proposed technical solutions were reasonable, i.e. judge the strengths and weaknesses of the OWL approach, analyse feasibility issues, evaluate cost and schedule estimates, and identify the main risks of the project and areas to be further explored. The second was to recommend whether and how to proceed to a next phase of the project.

The panel praised the OWL team for an extensive and largely successful feasibility study for a 100-m ELT. A strong technical point stressed by the panel was the integrated approach chosen for the OWL active/adaptive optics system, with in particular at least one large adaptive mirror as an integral part of the telescope.

Substantial technical risks were however identified, associated with OWL's double segmentation (M1 and M2), the highly aspherical M4 mirror and the telescope size that makes it Laser Guide Star 'unfriendly'. In view of these risks, but also of a consolidated cost (~ 1.2 G€) larger than the likely available ESO resources in the 2008–2020 time frame, the panel recommended to consider a smaller diameter, less complex and less risky ELT. It emphasised that most of the OWL design effort and virtually all technological developments started so far were directly useful for this new phase. In addition the panel recommended to strongly involve the ESO community in all aspects of the project and to speed up the currently running ELT site selection programme, with additional attention given to starting government level negotiations for site access as soon as possible. The panel concluded recommending "that the project proceed to Phase B, and begin with a new examination of the balance between science return, competitiveness, AO performance, instrumentation, risk and final performance within an affordable cost." It noted that the time to carry out such a re-evaluation was already in the plans proposed in the Blue Book.

The ELT design study

ELT-related R&D efforts are now accelerating, with a five-year programme started by European astronomical institutes and industries through the ESO-coordinated FP6 ELT design study. With a consolidated 30.5 M€ budget (including 8.4 M€ from the EC), it is aimed at establishing generic technologies critically

required for any ELT through the development of new concepts, advanced components, realistic simulations, breadboards and prototypes.

Towards the European ELT

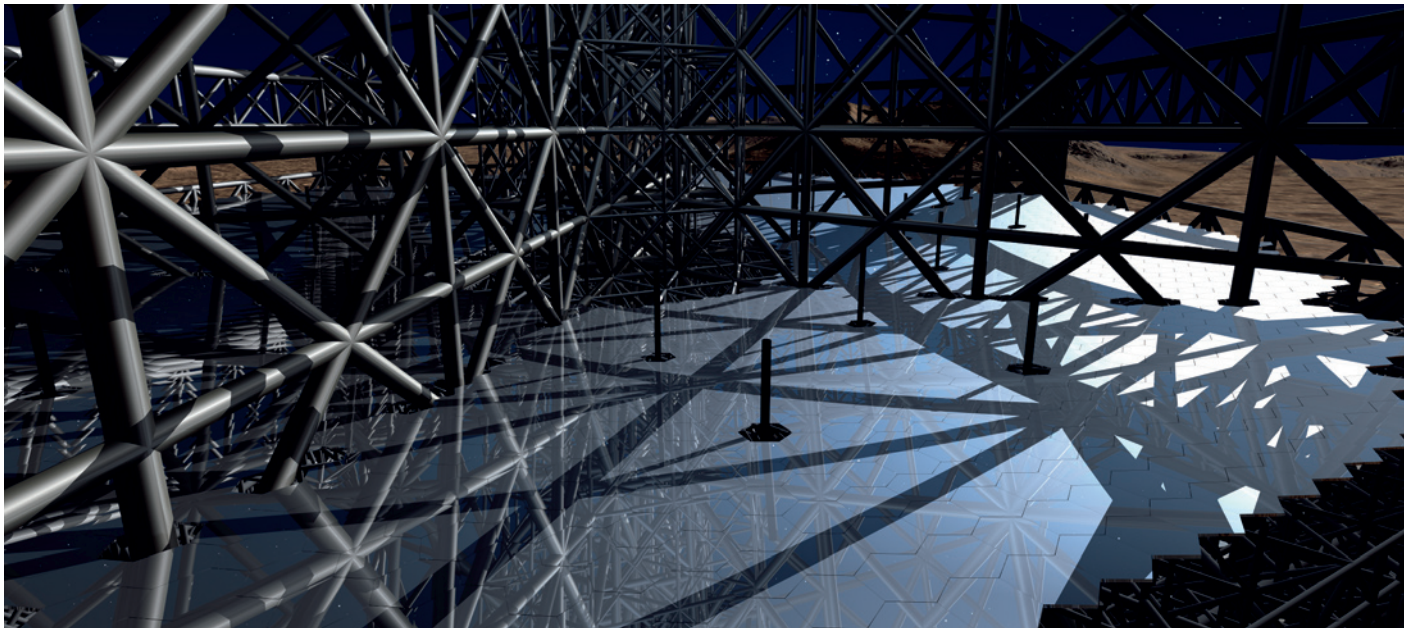
Following the review, the already planned two-year consolidation phase towards the final project has started as advocated by the review panel. As it noted, most of the building blocks developed for OWL remain valid for a smaller-size telescope and we expect to develop a basic reference design for what is now the European ELT project by the end of 2006. Our basic goal is to define the best affordable ELT that can be built on a competitive time scale and with acceptable risks. While the project is open to international collaboration, we definitely need to get a baseline design that could be handled within Europe alone, should no other major partner be found.

The process of definition of the E-ELT has been kick-started by mixed community-ESO ELT Working Groups (a.k.a. ELT-WGs) set up by ESO's Director General at the end of December, one for each of main ELT areas, namely (a) its Science case, (b) an Instrument suite, (c) the associated Adaptive Optics systems, (d) the Telescope and Observatory Design and (e) potential Sites evaluation. Their respective chairpersons are: Marijn Franx, Leiden (Science); Colin Cunningham, UKATC (Instrumentation); Gérard Rousset, Observatoire de Paris (Adaptive Optics); Daniel Enard, formerly VIRGO (Telescope Design); and Roland Gredel, Calar Alto (Site). Amazingly – a clear mark of the deep interest and commitment of the community – of the more than 90 WG members (60 % external, 40 % ESO) contacted on 22 December, only two were not able to join at such short notice, due to pressing ESO-related tasks. The brief of the five ELT-WGs called for a two-month burst of activity in January–February 2006 to produce an initial input to the ESO Team in the form of 'toolboxes', synthesising and collating ELT-related present and projected capabilities in their respective topic areas, as well as a first cut at a prioritisation of the requirements. This effort has just ended with all contributions received in time and with the proper content.

Present efforts by the former OWL team – soon to be expanded and restructured as the ELT project office – are primarily focussed at producing the ELT reference design, with as few remaining open options as possible by the end of the year. This involves a multiple iteration process between the main ELT ingredients listed above. Continuing with a strong community involvement during this critical step is essential. To that effect, the ELT Science and Engineering external Working Group (ESE) suggested by the OWL review panel, or rather a 'core' version of it, has been created to consolidate the reports of the five working groups into a recommendation to ESO (by May 2006). This 'core' ESE is composed of the ELT-WG chairs and co-chairs while the other members of the ELT-WGs will act as ad-hoc experts for ESE until at least the end of 2006. The ESE proper will be set up by STC in the spring to help and advise the ESO ELT project office in the complex iteration loops ahead, hopefully weaving successfully Science, AO, Instruments, Telescope Design and Site requirements to define the basic choices and produce a coherent and powerful ELT project for Europe by the end of the year. To ensure an even wider interaction with the community, the project draft basic reference design will be presented and discussed at a topical workshop in mid-November 2006 in Marseille (France), in time for a final 'loop' before presenting a definite plan to the ESO Council in December 2006.

Acknowledgements

The OWL study has been the combined effort of many people, both inside and outside ESO, over many years and we want to thank them all. We are also very grateful to the Review Panel members for their timely and highly constructive criticisms. Finally, we thank both the external and internal members of the ELT working groups for agreeing to help at remarkably short notice.



Visualisation: H. Zodet, ESO