# Tessellations

News And Technical Updates From Tessella

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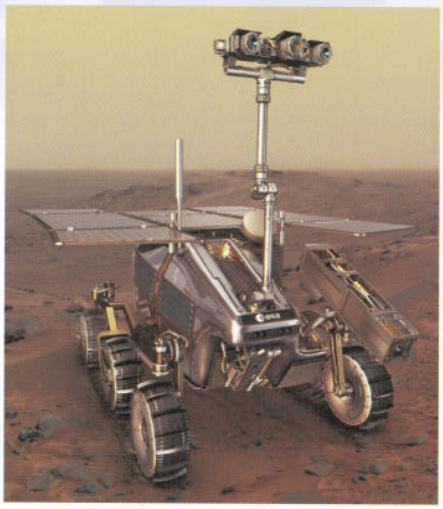
## ExoMars: a world of trade-offs and sensitivities

ExoMars – a European mission to land a scientific rover on Mars to look for signs of life – is currently in development and planned for launch in 2013. Funded and led by the European Space Agency, the mission will consist of a carrier spacecraft (to transfer it to Mars) and a descent module. After reaching the Martian atmosphere, the descent module will require an Entry, Descent and Landing System (EDLS), which will make use of a heatshield, parachutes, thrusters and airbags to bring the lander containing the rover safely to rest on the planet surface.

The current contract for the Phase B1 study phase of ExoMars was awarded to Thales Alenia Space Italia, with the challenging task of consolidating the baseline design for the entire mission. This involves balancing scientific objectives, cost and schedule, risk of mission failure, and political factors such as the effective use of the industrial partners distributed around Europe.



*The ExoMars rover will be ESA's field biologist on Mars (Image: ESA)*

To support this work, analysis and trade-offs of the available launch, transfer and EDLS options are being performed by Deimos Space S.L. (based in Madrid). Analyticon (now a branch of Tessella) is part of their team, with responsibility for analysis of the descent and landing phases.

As the ExoMars project has progressed, many different options have been discussed: launch rockets (with limits on the total mass that can be launched), arrival trajectories at Mars, landing sites and altitudes, and parachute/airbag technologies. Within this rapidly changing landscape, the project team needs to explore questions such as:

- What range of designs is feasible?
- Which landing sites are reachable?
- How large do the parachutes, airbags and thrusters need to be?
- How would a larger rover affect the capability to land safely?
- Which descent module release strategies are compatible with the landing accuracy requirements?

In many complex projects, eventual success depends on getting an early understanding of the trade-offs and sensitivities involved. There is a need to assess rapidly different design or development options, and find a balance between conflicting requirements.

In a project like ExoMars, where the constraints are both challenging and likely to change, such 'system-level trade-offs' are vital – gaining insight into the crucial parameters and helping to find the optimum solution at each stage.

For ExoMars, taking a numerical approach to mapping out the 'landscape' of available design options has supported the international community in deciding on the best way forward for the mission.

Deimos and Analyticon have developed tools to make numerical assessments of these questions in a way which allows rapid assessment of a wide range of options and, crucially, rapid re-assessment in changing circumstances. A technique developed by Deimos calculates the 'reachability' of each part of the Martian surface and shows it in the form of a map, taking into account the required landing accuracy, capability of the heatshield and so forth. This allows, for any given mission baseline, a clear view of the capability to meet the requirements and the amount of margin.

At Analyticon, a 'parametric analysis' approach calculates the required size and mass of the parachute, thruster and airbag systems for any given set of input parameters. For example, the effect of a heavier rover can be assessed immediately, or the optimum balance of parachute size against thrusters can be investigated. With bigger parachutes and more thruster fuel the descent module can slow down more quickly, which may be safer, but at the cost of more EDLS mass – which means less mass for other items like the scientific instruments.

With the help of such analyses, ESA has been able to agree with the participating states the mission baseline on June 11, 2007. ESA is now focused on refining the design of the so-called 'Enhanced Baseline' which provides a maximum science return to the European scientific community while maintaining the goal of demonstrating important technologies for future exploration missions to Mars. ESA is now preparing for the transition from the study phase to the implementation phase which should start in early 2008. With Analyticon also responsible for detailed simulation of the descent, and involved in the design of the parachutes themselves, this exciting mission will continue to offer many opportunities in the future!

### Design trade-offs in your business?

Design trade-offs and sensitivities are common in other industry sectors in which Tessella's clients operate. Sometimes a numerical approach is obvious, as in portfolio planning in the pharmaceutical industry, where risk and potential financial return need to be balanced against other factors such as strategic fit, within overall constraints on development resources. In other cases the criteria are more qualitative, such as in the defence procurement market, where a particular operational requirement could be met by a range of solutions which need to be assessed in terms of their cost, combat effectiveness, expected reliability in the target environment, and flexibility of application to other requirements. Working with partners and suppliers who understand your constraints and objectives, and have the technical expertise to explore them, is key to gaining the insight you need to support design decisions.

Analyticon

The Right Answer

**DIGITAL ARCHIVING**: On the 1st and 2nd of November 2007, the National Library of the Netherlands is holding an international conference highlighting the latest developments in digital preservation tools and the latest trends for long-term archiving. Dr Rob Sharpe (Tessella's Head of Digital Archiving Solutions) is co-presenting a session on the characterization of digital objects. For more information please email info@tessella.com

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