

EC RESEARCH TO AIM AT END USE



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Maurice has been a construction journalist for over 30 years, and is a former miner

WORK COMMENCED in September on the seventh European Commission (EC) funded research project for the tunnelling industry. Known as the NeTTUN (New Technologies for Tunnelling and Underground Works) Project, it was launched at the Ecole Centrale de Lyon, France, on 14 September in the presence of 21 industry, research and development laboratories and SME participants from nine European countries.

Funding is coming from the EC's Seventh Framework Programme for Research, Technological Development & Demonstration (FP7 2007-2013) under grant agreement 280712.

The project has been initiated and will be managed by NFM Technologies, the French TBM manufacturer, and will combine R&D elements of NFM's own development priorities, and those of other NeTTUN industrial partners, with requirements put

NeTTUN Project participants are 'end users': Metro C SCPA (Line C) in Rome, the Spanish contractor Obrascon Huarte Lain, and the French contractor Razel SAS.

The project's programme, agreed with the European Commission, has four themes and five main objectives. "Most subjects were already part of our R&D programme here," said Camus, "but the EC also wanted us to address subjects not related to TBM tunnelling. These were mandatory, so in addition to previous development partners, we have also contacted other organisations that we did not know personally."

PERIOD

The project is scheduled to last 4.5 years although Camus anticipates that some work will continue after the end of the project if the need and funding is there.

An unusual aspect of the programme is that it will be integrated with projects

2. Advanced robotics for TBM maintenance enable automation of routine but hazardous tasks;
3. Cutters tools with a greatly increased useful lifetime;
4. A novel system for the modelling of global risks, to be used for the definition of the best strategy for during both project design and construction phases;
5. A suite of systems to model and control the impact of tunnelling on surrounding structures;
6. A decision support system for tunnel maintenance.

The common theme to all of these is to meet end-user expectations with the target of putting tunnelling in a better business position. In order to keep the research findings relevant to end use NeTTUN plans to test and evaluate its activities in actual tunnel operations including the Rome Metro Line C construction, which runs under the Guadalquivir River near Spain being administered by OHL, and Razel Fayat's work on the Fréjus Tunnel.

It was a NETTUN initiative to appoint a five-member independent advisory panel of tunnel experts. "We thought it best to have people that can offer advice but who are not involved in the project," explained Camus, "so that that they have a referee position between NeTTUN, end users and the EC."

One of the matters of particular concern to the EC FP7, Dr Camus explained to *Tunnels*, was the viability of computer software development. "For this reason," explained Camus, "we have a software expert on our advisory panel who

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forward by the EC and its advisors.

NeTTUN leader, Thomas Camus, NFM Technologies R&D manager, emphasised to *Tunnels* that the emphasis of the project's themes would be on findings of most use to 'end users' interested in the construction, management and maintenance of tunnels, and be kept as end-user-friendly as possible so that they could be applied to a wide range of tunnel projects. Three of the

organised by the end-user participants.

GOALS

The ambitious goals set by the EC and the NETTUN participants themselves are:

1. An advanced multi-sensor ground prediction system for TBMs for fast, frequent and effective detection of ground anomalies ahead of the face;

provides guidelines in terms of software development with a goal of producing software that can be commercialised."

On one of NFM's priorities, that of a multi-sensor ground prediction system for TBMs, Camus said, "Although there have been attempts at some methods, there has not been enough effort put into methods for ground investigation in front of the face. 'Off-the-shelf' equipment in ground-probing radar, for example, is not designed for TBM use and does not work properly. The requirement is horizontal, rather than vertical, and there are thousands of tonnes of steel around that distort readings. Standard TBM layouts are not designed for the necessary instrumentation, so any detection method has to be integrated into the overall TBM design."

Regarding the other method often promoted, seismic 'mapping', Camus said, "Most of the current work is for hard rock using explosive charges in holes drilled into the sides of the rock tunnel, as this is feasible, but it won't work like that for soft-ground TBM tunnelling."

"You cannot drill through the precast concrete lining to place charges, and seismic wave propagation is not very efficient in that direction."

ROBOTICS AND TOOLS

The aim of robotics development is to produce ways of changing TBM cutters without resorting to compressed air or other inherently hazardous means of gaining access to the cutterhead mid-drive.

Another aim directed at more efficient cutter usage is to improve the life expectancy of tools. "Although a lot of work has and is still being done on disc cutters," said Camus, "not much has been done on improving the wear of static tools such as picks, rippers and scrapers."

While they are cheaper, there are usually a lot of them on a cutterhead, so improvements in wear should bring worthwhile savings."

PROJECT RISK

Considering the uncertain current state of many national economies, and previous costs and time over-runs that have tended to give tunnelling a bad name, the programme aim of 'modelling global risks' by a universal method should have particular value for end users.

As required by the EC, the target is to be able to say how sure the contractor and engineers will be of completing with planned time and budget.

The programme will assess project risks and the probability of acceptable completion, especially if all likely problems happen to occur in the same project.

The programme will include

NeTTUN Consortium Members

NFM Technologies manages the scientific and technical aspects of the projects, and the Ecole Centrale de Lyon, a top-level French engineering college involved in international research, is the NeTTUN coordinator.

- BG Ingenieurs Conseils - France
- Center d'Ingenierie des Systemes de Telecommunication en Electromagnetisme et Electronique - France
- Deutsches Forschungszentrum fuer Kuenstliche Intelligenz - Germany
- Ecole Centrale de Lyon - France
- Ecole Nationale des Travaux Publics de l'Etat - France
- Ecole Polytechnique Federale de Lausanne - Switzerland
- IDS Ingegneria dei Sistemi - Italy
- Inexia - France
- Metro C SPCA - Italy
- MI-Partners BV - Netherlands
- National Technical University of Athens - Greece
- NFM Technologies - France
- Obrascon Huarte Lain - Spain
- Razel - France
- Sial.Tec Engineering - Italy
- Societe Nationale des Chemins de Fer (SNCF) Francais - France
- Tallinna Tehnikaulikool - Estonia
- Technische Universiteit Delft - Netherlands
- Universita Degli Studi de Roma Tor Vergata - Italy
- Universite de Limoges - France
- University of Leeds - UK

feedback from earlier projects. Thomas Camus commented, "Risks are often underestimated, so to try and avoid this we will be including parameters not previously taken into account, to obtain a projection of the final cost. If the forecast costs and schedule are unacceptable the method can suggest actions such as more geotechnical surveying, using another mode of excavation (in dual-mode TBMs, or changing the type of TBM), and assess the suggestions in various scenarios."

This is also related to the aim of developing a suite of systems to model and control the impact of tunnelling on surrounding structures.

When asked how the aims of this work package differ from systems that are already being introduced, Camus said, "We will use both physical modelling and numerical modelling for the same type of ground and excavation method. The work is closely related to the Rome Metro Line C where there are concerns about the impact on ancient monuments."

In comparison to previous work he says, "We want to make modelling results available in a simpler way that all projects can use. Existing models are generally complicated. Our study will be paid for by future projects in other tunnels, and validated in the field."

As with the Rome Metro, the other 'end users' in the NeTTUN Consortium will be able to supply project information for the

work packages and to assess developments in the field in existing and future projects.

REFURBISHMENT

In view of the predictions of a high proportion of tunnels work in Europe being in need of refurbishment, end users have been keen to have a way of assessing and programming necessary work in terms of priorities and project costs. "Most operators have been carrying out repair work, usually in small sections, according to urgent need (such as water leaks and section subsidence), and leaving the rest of the tunnel until later. As a result tunnels can have a complex history, making assessment of future work needs difficult."

"Clients want to know what tunnels are most urgent to take care of, and how much should be worked on," said Camus, "There are a lot of parameters to include in the decision support system, including the importance of end use (transport route usage for example), safety and the likely speed of degradation without refurbishment. The most urgent needs may not be obvious without analysis."

Concluding Dr Camus says, "NeTTUN will deliver maximum impact with its results, well beyond the current state of the art, to demonstrate real progress that can be utilised to the benefit of the tunnelling sector across Europe, and for European industry with research and development to compete globally" 