Risk managers of the ground

Using almost three decades of work to reduce project delivery risk below the ground, geo-data specialist Fugro has created its Ground Risk Management Framework.

As the ground represents a significant source of risk for civil engineering projects, Fugro wanted to outline how it can help better manage this so project owners and developers could have better outcomes.

The Ground Risk Management Framework (GRMF) formalises Fugro's way of working around site characterisation and geotechnical engineering as well as addressing construction and asset operation challenges. It also introduces a structure to help clarify the thinking about ground-related risk management.

Fugro solutions director for land site characterisation Rod Eddies explains: "The philosophy underpinning the GRMF centres on a good understanding of project owners' business objectives, or endgame, and then finds the best means to get there – so the GRMF provides a flexible framework that needs to be tailored to each project and for the role of client stakeholders within it, including owners, consultants, constructors, insurers and so on".

The framework broadly comprises six solutions. Fugro defines flexible solutions as combinations of expertise, services and resources targeting particular project phases. These solutions are delivered at the deltas (Δs - *see diagram*) over time; the deltas also represent data interfaces where information needs to pass efficiently from one phase of work to inform the next – this has enabled Fugro to identify data management gaps and work on better ways to reduce data friction – including near-real time data transfer from the field.

The framework has also enabled Fugro to identify technology gaps in ground-related risk management. The company has been able to fill some of these with solutions from other industries through cross-pollination.

Fugro director of land site characterisation USA Ray Wood explains: "A significant component of our thinking has been the integration of remote sensing using geophysical techniques with the more physically intrusive investigation techniques that you conventionally see in geotechnical engineering."

As Fugro has been a significant player at the complex end of deep hydrocarbon exploration using geophysical techniques, it has put effort into rescaling those techniques for the engineering market.

Wood continues: "Obviously the land and marine engineering markets have had the imperative and the resources to invest much more in the advancement of remote sensing techniques than the civil engineering industry ever had. These have given us a clarity and a level of fidelity from geophysical techniques that have considerably improved their effectiveness in the near surface."

Eddies adds: "There have been predictions over the past decade or so that far more resources will be put into geophysics of the top 100m than of the next several kilometres, because this is where our future battleground lies, characterising and reducing uncertainty in the near-surface. We can bring scalable solutions in from, for example, oil and gas and mining to fill the technology gap."

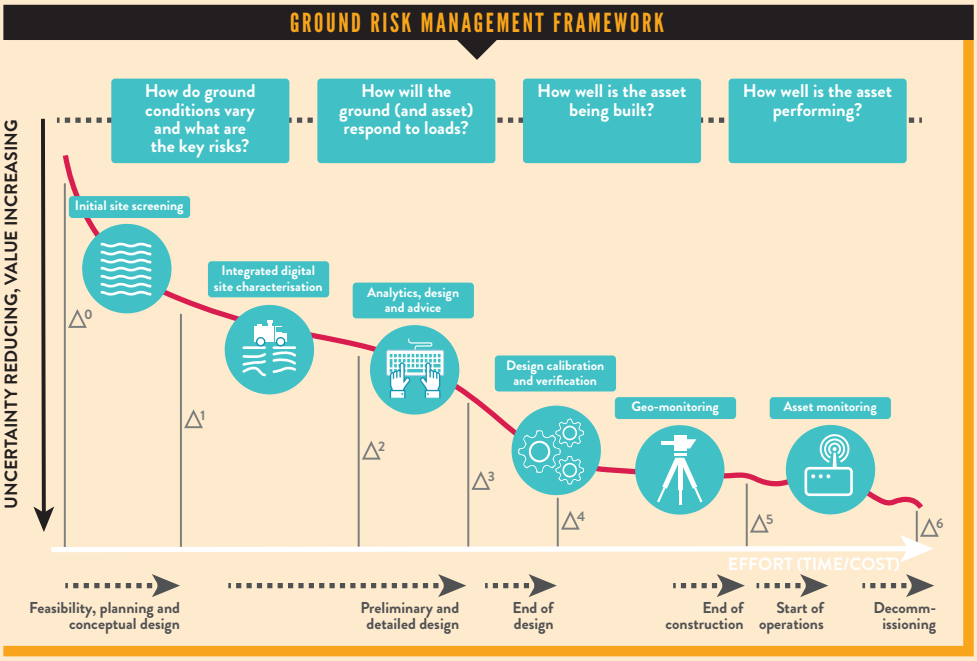
When it comes to initial site screening, it is of course best to determine major risk related with the ground early on.

"We recognise in Fugro that initial site screening as the first solution delivering geo-data in the cycle is a very important step in mitigating ground-related risk," Eddies says.

"Clients can get quite a lot of bang for their buck at this stage where the cost of project change is relatively low for owners. There are technologies that can, for example, using satellite imagery, identify deformation, differential ground movement, which is useful all the way through the cycle.

"I think some of the key advances on the initial site screening have come from geophysics. We have screening techniques that effectively deliver 2D slices. But of course, we do not live in a 2D world; and, where we would like to move towards in initial site screening is not so much slices but boxes of information – such as new 3D passive seismic approaches."

Geotechnical engineers are often expected to be able to create a design for a whole site based on seeing only a



small proportion of it.

"There's a general adage that all models are wrong, but some are useful," Eddies notes. "Of course, the truth is, most models are formed of a little bit of something and a lot of nothing. By integrating geophysics and remote sensing with direct investigations, we can populate that model space much better. It starts to become useful."

Ground-related risk, of course, does not end at the design stage, continuing into construction and operation of assets.

"There are questions that we do address within the framework post-design," Eddies says. "These include how well is the asset being built, which relates to how well the specification that is set has been met, how is the constructor performing, and whether the construction is being built safely, and then beyond that in a much longer operational phase.

"The GRMF is highly nonlinear along its time axis through to the long asset operations phase.

"We need to understand through geo-data derived through monitoring technologies how the asset is performing to inform and optimise maintenance programmes – mindful that opex expenditure can significantly increase whole-life costs of an asset in the longer term."

The GRMF offers flexible solutions that reduce uncertainty through the project cycle, delivering at the deltas/Δs that are also data interfaces between key project phases. The framework is used internally at Fugro to build bespoke solutions addressing the needs of client stakeholders

REDUCING RISK BY REDUCING UNCERTAINTY

Fugro understands that the core business of developers – whether in the public or private sector – is not dealing with the ground.

"The ground is simply a hindrance to them to achieving their ultimate business objectives. Their business objective is to deliver a piece of infrastructure that provides a worthwhile return on the investment," Wood says.

"A lot of this then speaks to whether projects can be delivered cost-efficiently and whether they can be delivered with certainty of outcome. This then relates to both outturn cost and time to delivery.

"Many of us are taught that value for money and certainty of outcome is a trade-off. If you want a more certain outcome, you somehow must invest more in your endeavour. I believe, as geotechnical engineers, we are an uncommon breed because of the uncertainties of dealing with the ground. If we can do a better job of geotechnical engineering, in terms of the total capital cost of a project, we will deliver greater value for money without compromising certainty of outcome."

This is, in turn, all linked to better management of ground risk. However, risk management can be a rather abstract concept.

"If you accept that risk derives from uncertainty," Wood continues, "the problem then becomes much more tangible. From the concept of ground engineering design, we really only have two sources of uncertainty prior to construction: what are the ground conditions beneath and surrounding our site? And how does the ground behave under the proposed structure?"

Overall, Fugro wants its clients to do the right things well. As budgets for site characterisation or ground investigation tend to top out at 1% to 1.5% of the total capital cost of a project, this could mean spending another 0.5% to better populate the initial ground risk model.

"It could also mean doing a few more intrusive investigations in the right place," Eddies says. "But the gearing between that relatively modest level of investment could yield maybe 20% to 25% savings in the geotechnical construction cost that will positively impact total capital costs in turn, for more economic construction.

"I think this is one of the key messages we want to get across. This is not an abstract approach; carefully tailored to the project, it can lead to greater foreseeability, more effective transfer of ground risk between stakeholders and tangible cost savings."

And why is this important? Based on research by Oxford's professor Bent Flyvbjerg and others, Fugro identified that average overruns in the three key sectors of mining, oil and gas and infrastructure are still running at two years plus for larger projects, with cost overruns of at least 80%.

"This obviously doesn't bode well for the some of our key large infrastructure projects," Eddies says.

While the underperformance is certainly not all attributable to ground-related risk, Eddies believes it is a component – and a component that could be better managed.

"An effective way of managing that risk is through an approach that is defined within the GRMF," he says.

Wood concludes: "For the ground-related risk component of capital projects, we really feel something better can be done by following our approach. It offers a better way of managing the risk, and allows less dependency on code-based design and more emphasis on site-specific information and performance-based design."