

## Innovation

### Increasing value to our customers through the development and application of leading edge technology

Innovation is at the core of all Vesuvius activities. Maintaining technology leadership is a central objective of our strategy and, as we identify on page 19 a failure to develop and protect market-leading technologies could place our business at financial risk.

We regularly examine the structure of the R&D organisation and its processes for developing new technologies and applications to support Group strategy. This process will be enhanced following the appointment of our new Chief Technology Officer, George Coulston PhD, in October.

The innovation process starts with an intimate knowledge of our customers' processes and needs. We have more than 200 field applications engineers supported by local development teams on all continents. These local technical teams are constantly updated with the practical information on the latest technologies developed in our six global research centres.

These centres have connections with universities all over the world and our internal research and our cooperation with universities and technical centres is directed by a group of dedicated scientists and engineers whose mission is to ensure that both the short-term and long-term technology needs of our businesses are being met. We aim to strike a balance between maintaining a local presence and capturing the synergies and other advantages that come from organisations based in well-equipped global research centres. With this objective in mind, a new global Foundry research centre is under construction in Enschede, the Netherlands and will open during 2014.

Our customer-focused approach to research and development ("R&D") is critical to supporting the achievement of the objectives required by the Group's strategy.

We will maintain our technology leadership by:

- Continuously investing in the skills and knowledge of our employees through in-

house training programmes, as well as by hiring engineers from diverse industries, and leading universities

- Continuously investing in the latest analytical instruments, modelling facilities, and customer process simulation equipment so that prototypes of new offerings can be developed quickly
- Leveraging our understanding of customer processes to provide products and solutions that meet a customer's existing, as well as unarticulated, needs.

We have expanded our R&D budget by over 20% in the last three years, and have already begun to see benefits. As detailed elsewhere in this report, R&D expenditure is a key performance indicator for our overall business. We have filed 27 new invention and 150 new patent applications, in 2013, and also had 182 patents granted worldwide during the year.

Vesuvius solutions and products can greatly influence the quality of our customers' products and the efficiency of their processes. All our new products and solutions are developed with value creation for our customers in mind. We regularly conduct customer seminars and training sessions, which are given to a wide range of managerial, technical and operational staff. This seeks to ensure that the full range of Vesuvius products and solutions are known and properly used, so that the maximum benefits are derived.

The following two major innovations, one for the foundry industry and the other for steel production, clearly illustrate how Vesuvius can reduce its customers' costs:

- Foseco's unique, patented collapsible metal core technology continues to capture market share throughout all regions (sales have grown 50% in the last four years), delivering optimum feed performance, casting yield improvement and cleaning cost reduction. When foundry customers pour molten metal into a mould they need to account for

shrinkage, which will occur as the molten metal cools. This shrinkage can lead to a variety of defects and result in scrap. Known in the trade as "feeders", our products are a critical part of the solution to counteract that shrinkage and avoid scrapping the parts

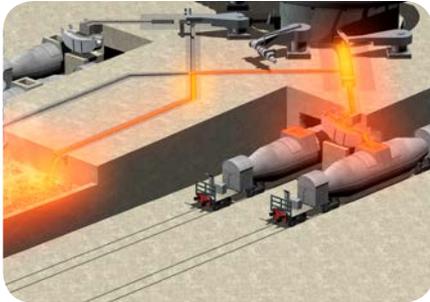
- Improved iron-making productivity and blast furnace operations with Lavagard™ Monolithic Refractory Solutions.

A fully engineered customer-designed solution to improve blast furnace up-time and productivity has significantly improved iron making operations at one of the highest output production facilities in the world. Working with blast furnace engineers using novel installation and application technology, Vesuvius engineers were able to recommend changes to the existing casthouse design and refractory system.

By incorporating products from the Lavagard™ suite of monolithic refractories, which included Lavagard™ FCX precast monolithics and Lavagard™ SZ pneumatically installed hot veneering repair materials, the blast furnace team was able to extend their scheduled rebuild and maintenance practices. This has resulted in a reduction of 20% repair materials and doubling of the tilter life.



Exothermic Feeder Sleeves with patented Compressor core technology, allowing more cost-effective complex casting designs (FEEDEX K)



Lavagard™ solution for blast furnace casthouse applications

Vesuvius local development centres are a key element in our strategy of capturing growth in developing markets. They are present in all regions, and include facilities for both physical and computational fluid dynamics. The centres ensure an immediate and local focus is applied to specific regional issues, ensure new opportunities are identified for our current product range, and bring newly developed products quickly to market in these fast-growing economies.

The R&D organisation has the direct responsibility to support the cost leadership element of our strategic objectives. A dedicated group of engineers specialises in raw materials, with the objective of deeply understanding raw material quality and its effect on Vesuvius products.

Vesuvius R&D is playing a key role in supporting the strategic pillar to build a technical services offering, by developing new products and capabilities such as:

- New instrumentation to monitor flow characteristics throughout various points in the steel casting process
- Data feedback systems and control schemes for real-time optimal flow control throughout the full casting sequence
- Integrated foundry systems and controls to help ferrous melt shop to produce quality products.

### Modelling Capabilities

The Vesuvius R&D team makes extensive use of sophisticated modelling tools to accelerate the rate of innovation. The use of Computational Fluid Dynamic ("CFD") modelling, thermodynamic modelling, and physical simulation tools, such as advanced water modelling, are now deployed throughout

the solution development process.

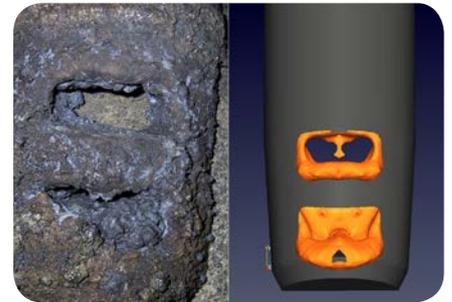
For example, these modelling tools allow experienced scientists and engineers to analyse the complex fluid interactions between refractory materials and molten metals which would exist in our customers' operations, and to predict the formation of undesirable impurities.

Consequently, potential problems with a product design can often be discovered and rectified before the design leaves the computer.

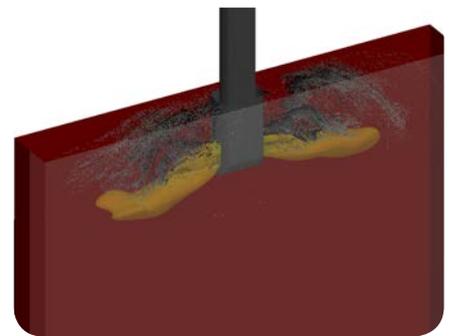
Advanced simulations are also used to understand how geometric changes to a refractory design impacts the flow of molten metal in our customers' facilities, which in turn impacts the quality of the product they produce. For example, gas injection into liquid metal, a technique employed by our customers to ensure homogeneity of temperature and composition in a melt, is extremely difficult to visualise in situ. Our CFD tools allow such mixing to be simulated and are extremely useful for determining the influence of the gas on the overall behaviour of the system. By combining this information with detailed understanding of the chemical interactions between refractories and molten metal, Vesuvius scientists are able to optimise designs and material selection.

The graphics to the right show how CFD modelling can be used (1) to visualise the flow of argon gas injection in a sub-entry nozzle used in a steel plant, and (2) to review the flow of gas in a steel ladle.

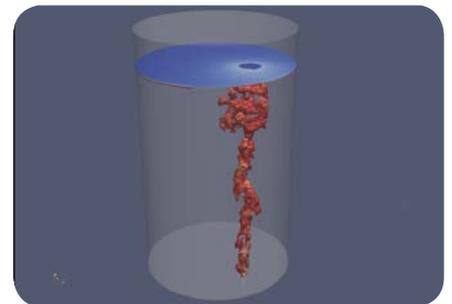
Vesuvius engineers are also able to create physical models of critical portions of our customers' operations to gain further insights into how certain products will perform. Our customers often participate with us in this modelling process, and they use the results to make their own design decisions. By working together with us, they are able to explore the pros and cons of various design choices, which would otherwise potentially have been cost prohibitive.



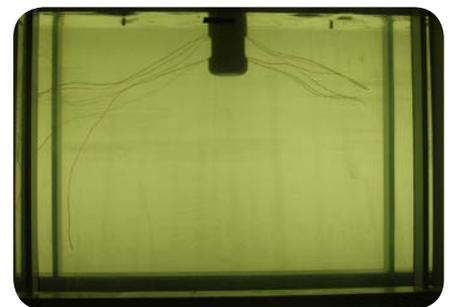
Numerical simulation of the high deposit potential region and the actual refractor nozzle after use



(1) CFD Simulation - submerged entry nozzle inside a slab mould with gas injection



(2) CFD Simulation - review gas flow in a steel ladle



A water model with string to visualise the contours of the port exiting jets