At 21m-long, the Compact Muon Solenoid is one of the larger particle detectors

Buying at the very edge of our understanding

Things can get complicated for the procurement team at CERN, when what the scientists need is often beyond the capabilities of industry

WORDS **REBECCA ELLINOR TYLER**

Save for a few remote tribes, there are few places left on the planet where people haven't heard of the World Wide Web. More recently, the 'Large Hadron Collider', which found the Higgs boson elementary particle, has also entered the modern lexicon. One revolutionised global communications; the other is at the very edge of our understanding of the universe.

What connects them is that both hail from the European Organization for Nuclear Research – or CERN – an intergovernmental organisation based in Geneva where physicists and engineers probe the fundamental laws of nature.

Momentous discoveries made at CERN, together with appealing clever-clogs personalities such as Professor Brian Cox, and a host of new TV and radio series for enquiring minds, have propelled science into the mainstream once again. CERN itself now receives more than 100,000 visitors a year, an exponential increase in recent times.

Supported by more than 20 member states, it receives funding of around €900 million a year. It is immune from national jurisdiction but instead governed by public international law, so any legal disputes between it and its suppliers/contractors are solved via international arbitration.

It also has its own procurement rules and procedures that differ from those in Europe. One such rule is the aim to achieve a balanced industrial return for all member states. In other words, it tries to ensure money flows back to the countries that support it by sourcing supplies from them wherever possible.

The Large Hadron Collider (LHC) is CERN's most famous particle accelerator, but there are several projects happening at any one time. The procurement teams buy everything needed to build and operate the world's largest and most complex scientific instruments, as well as anything else required to run the massive facility that straddles the French-Swiss border. ▶

The 32-strong procurement team sources anything over a threshold of CHF1,000, from catering and construction contracts to superconducting cable for the collider.

"CERN is like a small city of 15,000 people," says Anders Unnervik, head of procurement and industrial services. "It has 700 buildings, three restaurants, its own fire brigade and hospital, banks, post offices, two museums and a kindergarten. We have more hotel beds here than any hotel in Geneva."

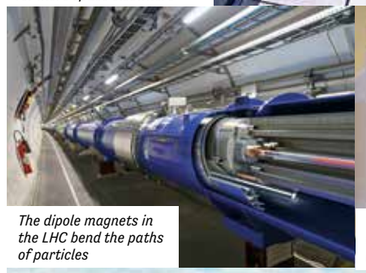
Twenty of his team are procurement officers dealing with orders and contracts with a combined annual value of CHF500m. CERN employees can make low-value, low-risk purchases directly using the contracts and templates already set up; but for bigger deals, they're expected to see the procurement department, and "the sooner the better".

CERN's requirements fall into three categories: standard, off-the-shelf, industrial products; non-standard products that can be produced with existing manufacturing techniques and/or technologies; and new high-tech products requiring a conceptual design phase, where industry lacks the experience, expertise or interest in developing them. In these cases, CERN is typically responsible for the development (also for the manufacturing methodology of these items) and issues build-to-print specifications to industry.

"Each category requires a different procurement strategy," says Unnervik. "Sometimes our requirements are beyond the capabilities of industry and so we develop our own prototypes and products."

It is a complication that comes with working at the very edge of science. The CERN name can attract suppliers but its challenging requirements can also put people off. Not only might the technology it needs not yet exist, sometimes the market isn't willing to invest the time and money required to make it possible. This can lead to CERN designing its own prototypes or working alongside industry for many years to produce specifications side by side.

With the computer centre already full, CERN has to look for more space elsewhere



The dipole magnets in the LHC bend the paths of particles

Tim Berners Lee invented the World Wide Web while working at CERN

The complex is home to 15,000 people

Maximilien Brice/CERN; Daniel Dominguez, Francois Briard, Andrew Strickland/CERN

What is the Large Hadron Collider?

10 facts about the world's most incredible experiment

1. It is the planet's largest and most powerful particle accelerator, smashing particles together at close to the speed of light and giving physicists clues about how particles interact.

2. The energy density and temperature produced in the collisions are similar to those that existed a few moments after the Big Bang, so it is hoped it will help understand how the universe evolved.

3. It is a 27km underground ring of interconnected magnets, straddling the Franco-Swiss border, and chilled to -271.3C.

4. The central part is the world's largest fridge. At a temperature colder than deep outer space, it contains iron, steel and superconducting coils.

5. Each of the 6,000-9,000 superconducting filaments of niobium–titanium in the cable produced for the LHC is about 10 times thinner than a normal human hair.

6. CERN made headlines with the discovery by physicists in 2012 of the Higgs boson particle, paving the way to a breakthrough in our understanding of how particles interact, and won the Nobel Prize in Physics.

7. When the circular tunnel was excavated, between Lake Geneva and the Jura mountain range, the two ends met up to within 1cm.

8. Protons at the design energy in the LHC travel at 0.999999991 times the speed of light. Each proton goes round the 27km ring more than 11,000 times a second. At full energy, each of the two proton beams in the LHC has a total energy equivalent to a train travelling at 150km/h.

9. There is more iron in the Compact Muon Solenoid particle detector (previous page) than the Eiffel Tower.

10. When the LHC is switched on it runs 24/7. It stops annually, and every three years it stops for 18-24 months for major repairs and upgrades – the next scheduled for end 2018.

> "We may work with technical experts for a year before the requirement has been decided"
>
> **CRISTINA LARA,**
> DEPUTY HEAD OF PROCUREMENT AND INDUSTRIAL SERVICES

SUPPLIER DEVELOPMENT

On the plus side, not only do suppliers get the kudos of working with or for CERN, there can be a commercial pay-off too. That has been the case for providers of superconducting cable for the accelerator. Necessary performance improvements that met CERN's spec have also now been sold for use in medical equipment.

"Sometimes it's easier for us to deal with something new in the development stage," says Unnervik. "If we do it ourselves, any modification can be quickly handled and once we've frozen the design it can go to industry. But we cannot produce superconducting cabling ourselves, so we've had to work for many years with industry to produce new and better cables."

In the case of some cryogenic equipment, there was just one US supplier who could provide what CERN needed. So, to boost competition and generate return for a member state, CERN worked with a European company, which is now, two years later, recognised as a competitor to the US business.

The procurement team has already picked up a European award for excellence and the innovation opportunities it offers suppliers. It has been praised for its solid procurement processes, education of stakeholders, industry days for suppliers in member states and its work to market future requirements five to 10 years in advance.

For Unnervik's team, flexibility and innovation in the procurement process is of utmost importance. "If a strategy does not work as planned because of unforeseeable conditions, you have to be prepared to change strategy. We also carefully evaluate the benefits versus costs related to dual sourcing, ensure competition throughout the entire bidding process and follow up contracts carefully."

Working with a single supplier on some of its projects would be far too risky, so the team works hard to expand the market, reaching out to new and potential suppliers in a number of ways.

It has a supplier database and organises and attends events in member states to connect with businesses – like next year's Big Science Business Forum in Copenhagen. It also uses industrial liaison officers to help find suitable companies in those countries and will reach out to peers in other research labs for supplier contacts.

There is some collaboration between research facilities across the globe, especially where they can make use of CERN's size and experience, but teaming up on sourcing can prove tricky because the same purchasing rules do not apply.

The procurement professionals working at CERN don't have to have dark-matter-probing PhDs themselves, but it helps if they've had a background in defence, research or high-tech sectors. And for complex equipment purchases they work with the physicists and engineers. "There's close teamwork between procurement and the experts in the field," says Unnervik.

"We may work with technical experts for a year at minimum even before the requirement has been decided," adds Cristina Lara, deputy head of procurement and industrial services, who says they may also pull engineers and physicists into negotiation rounds.

But it's not necessarily the technical stuff that is the toughest to source. "There are challenges in innovation but we buy anything you can imagine, so sometimes it is the easier categories that can be a nightmare," she says.

CUTTING-EDGE PROCUREMENT

For many of the specialist items the team purchases it has to try to stimulate the supply market to generate competition. One area where it faces near domination by a single supplier is with electricity. "The supplier that has the biggest turnover with CERN is our electricity company. We spend an awful lot of money on it, it's almost a monopoly," says Unnervik.

The power required to run the machines is equivalent to that of a small city. Its 200-megawatt daily requirement equates to 1.3 terrawatt hours a year and while CERN does all it can to reduce power consumption, more than 90% of its bill is spent running the particle accelerators, so other measures have a negligible effect.

CERN's computer storage requirements are equally staggering. "We store 130 petabytes of data – that's the equivalent of watching a 700-year-long high-definition film. The LHC alone creates more than 30 petabytes of data a year," says Unnervik.

"We cannot expand our computer centre any more, it's full. A few years ago we placed a contract for a computer centre in Hungary but with new experiments at CERN it's not enough – so we either have to build or rent a new one."

And they're not immune to cutbacks. While the team tracks savings and reports on them to management and member states, because it doesn't buy the same things annually, it's hard to compare year to year. Instead it concentrates on where it can add the most value and ensures it avoids becoming a bottleneck.

Needless to say, Unnervik and his team get a lot of job satisfaction from working at the cutting edge of science: "We're proud to be part of it, most people here are."

Lara adds: "One of our recruits told us he'd been trying to work for CERN for 10 years (he's 27). He had to think about what he wanted to do and how to work here. And now he works in procurement he says he has to pinch himself to believe it." SM