

from **ROCK**  
to **ROOF**



# from Rock to Roof

FOLLOWING THE JOURNEY OF THE COPPER

**Virgin copper is not the obvious choice for roofing a high profile sustainable construction project such as Eden's iconic education centre – the Core – but the copper used on its roof conveys an important message: global demand for copper (and other metals) continues to grow and, at most, only 40% is being met by recycling; we all have a vested interest in ensuring the outstanding 60% provided by the mining industry is supplied as responsibly as possible.**

**The Core's copper roof offers an example of what is possible – the copper itself was tracked from a single source - a copper mine renowned for its high environmental and social standards - across the world and through various production processes - to its installation at Eden.**

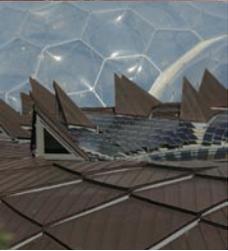
**This document relates the inside story on the copper roof: the architect's brief, the rationale, choices and decisions - and the future.**

## **The Core**

The remarkable new education centre, 'the Core', was built to demonstrate and communicate the key message at the Eden Project; mankind's fundamental dependency on the earth's resources. It is an inspirational hub for events, exhibitions and learning for all. The building itself is an exhibit in its own right. Educational in form as well as function, it is inspired by natural form, crafted largely from natural materials and a thought-provoking exemplar of sustainability in its approach, design, construction and messaging.

## **The Design**

The building's design mimics that of a tree: the architects, Nicholas Grimshaw and Partners, designed the roof to be analogous to the canopy with the central trunk as a structural core and roots represented by the foundations and servicing of the building. The roof covering provides dappled natural lighting and shelter and includes photovoltaic panels that mimic the function of photosynthesis. The building's timber grid shell is a direct representation of phyllotaxy - the geometric patterns found in leaves and flowers, the blueprint of how plants grow - and the Fibonacci principle underlying this (see box below). At the centre of the structure will be a large stone sculpture, "the seed", by artist Peter Randall-Page, providing the conceptual heart and anchor for the building (due for completion later this year).



## Fibonacci...

12th Century mathematician Leonardo Fibonacci codified patterns of growth that typically conform to the numerical sequence 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, etc – each number being the sum of the previous two.

This sequence can be seen clearly in nature as opposing spirals. The seed head of a sunflower, a pine cone or a pineapple all have obvious series of spirals that go in two directions. The number of spirals in each direction will respond to the consecutive number in the Fibonacci sequence. For example, in pineapples you will see 8 spirals sloping to the left and 13 to the right; the sunflower will typically have 34 clockwise spirals and 55 anti-clockwise. Our roof has 21 anti-clockwise and 34 clockwise spirals

## ...and phyllotaxis

In most plant species new growth propagates from central regions called shoot apical meristems. The meristems create primordia which develop into plant organs (seeds, leaves, petals etc) and collections of primordia form into patterns which are retained as the plant develops. The study of these patterns is known as phyllotaxis.

All plants grow from a central point but remain in proportion and keep the same spacing. In the case of the Core roof, the particular pattern is based on spiral phyllotaxis and can be commonly seen in nature, for instance the seed head of a sunflower or a pine cone. Each node within the roof structure represents the idealised position of a seed on a seed head.

## Materials

Eden's aim was to build the Core with the highest sustainable specifications – challenging the conventions for sustainable design and construction – with targets above the national benchmarks and using carefully selected materials. The team considered the complex interaction between a range of criteria of sustainable issues, specifically waste neutrality, positive futures, recycled content, certification of materials and local sourcing implications.

## The Roof

The key criteria affecting the choice of roofing material were:

- to make a bold architectural statement to complement Eden's ground-breaking architecture and landscapes;
- to be durable, strong and relatively lightweight;
- to be malleable enough to cope with the complex structure of the roof;
- to have excellent sustainability credentials, and
- most importantly for a building dedicated to education at Eden, the roof should highlight a progressive message relating to sustainable development issues.

## The Choices

Whilst recognising that there is more to sustainability than just the environmental impact, current practice in the UK is to assess building elements on a comparative basis using Envest, an environmental software tool that presents the assessment in terms of ecopoints<sup>1</sup>. Envest is part of the UK's Building Research Establishment (BRE)'s assessment methodology.

Timber, aluminium, copper, zinc and stainless steel were all deemed suitable to varying degrees and were analysed for their properties, their environmental impacts, aesthetics in relation to the Eden site, and the overall educational value of their use given the unique Eden scenario.

Certified timber, as a renewable resource, naturally outweighed the metals on the Envest system. However, for this roof structure, a sarna membrane<sup>2</sup> would have been needed and critically, there are no figures on Envest for this yet. Timber would also not have been as durable as metal over a long time frame.

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1 A UK Ecopoint score is a measure of the overall environmental impact of a particular product or process covering the following environmental impacts: climate change, fossil fuel depletion, ozone depletion, freight transport, human toxicity to air, human toxicity to water, waste disposal, water extraction, acid deposition, ecotoxicity, eutrophication, summer smog and minerals extraction

2 a sarna membrane is a thermoplastic single-ply roof membrane



All the metals compare favourably against each other in terms of functionality and durability. Copper and aluminium had the most interesting sustainability stories and recycled metals received respectable ecopoint scores, particularly if locally sourced. Recycled aluminium tells an environmentally important story but one which is already well-known, and recycling is already dealt with elsewhere at Eden by the Waste Neutral programme<sup>3</sup>. This left copper as the key choice.

While copper can be relatively expensive for a roof and is in strong competition with other roofing materials, it is robust – even when turned into sheets, malleable, completely waterproof and very long lasting: physical properties that made it ideal for the roof’s complex design. Aesthetically too, copper is the only common metal – other than gold – that isn’t grey-silver, making it one of the most easily recognised metals, thus aiding engagement with visitors as a first step to relating the sustainability message. What’s more it will gradually turn green in keeping with its ecological surroundings (and with the analogy of the roof being the canopy of a tree).

## Sourcing the copper

Once copper was chosen, Eden was presented with three possible sources to choose from:

1. the open market – where the vast majority of copper comes from. This includes an impenetrable mixture of copper from many mines (responsible ones and others not so), recycled and virgin copper;
2. 100% recycled copper – which currently supplies, at best, 40% of demand, and in terms of potential for Eden’s sustainability messaging, recycling as an issue is already comprehensively dealt with by the Waste Neutral programme; or
3. virgin copper from a single, responsibly-managed mine.

The copper roof provided Eden with the opportunity to investigate how we can supply the 60% of global demand for copper that isn’t recycled, by exploring the feasibility of sourcing copper from a single, responsibly-managed mine, and ultimately, generate debate on the potential for certification schemes in metals and minerals.

## The copper

The copper for the roof was donated by Rio Tinto and sourced from Kennecott Utah Copper Company’s Bingham Canyon mine, near Salt Lake City, Utah, USA – regarded as being among the most responsibly-managed copper mines in the world<sup>4</sup>. The copper is processed from the rock on site, through to the refining stage and leaves the mines as cathodes).

From Utah, the copper was shipped to KM Europa Metal, Osnabrück, Germany; one of the world’s largest manufacturers of copper and copper alloy products. EU importing regulations dictated that the copper had to be fabricated in Europe rather than be shipped from the US pre-fabricated. KME lead the field in the development of innovative, application orientated solutions. To ensure no contamination with copper from other sources, KME tracked our copper through their system according to the batch codes

They took the unusual step of clearing the fabricator of all other material before working on Eden’s copper – but special orders do come through the fabricator at times so the necessary systems are already in place for traceability from the casting stage.

At KME the cathodes were fabricated into rolls of sheet copper. These were shipped directly to Eden and cut to shape by specialist local roofing contractors on site.

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<sup>3</sup> See [www.edenproject.com/wasteneutral](http://www.edenproject.com/wasteneutral)

<sup>4</sup> One of the features of operations at Bingham Canyon has been progressive clean-up and regeneration. In recent years Kennecott has spent around US\$350 million on the clean-up of historic smelter operations. Since 1994 it has reclaimed more than 16,800 acres of land for wildlife and has planted more than 120,000 trees over the same period. ICMM Newsletter. Vol 5 Feb 2006

It also has a high health and safety record and strong reputation in community relations; ISO 14001 certification with a proactive environmental management programme including rehabilitation of large tracts of land and plans for eventual mine closure; and uses the very latest technology to control emissions including a smelter that captures over 99% of the sulphuric acid emitted during processing.



## The future

We recognise that the tracing of our copper from rock to roof was an unusual effort, with a heavy reliance on the goodwill of our Eden partners, Rio Tinto; but the key players in the supply chain were willing to help because they too recognised that a debate is needed over where and how we source our metals and minerals, particularly as in this case, for the construction industry.

The accreditation process in the timber industry has been a revolutionary step in advancing the monitoring and implementing of sustainable construction using timber, providing mechanisms for direct influence and choice by the customer. Monitoring systems such as Envest reflect the availability of this option.

How and where metals are mined and processed during their product life cycles from cradle (raw material) to grave (disposal) are usually unknown by the time the end product is disposed of. Life cycle assessments are increasingly used by the mining industry to provide a more comprehensive analysis of the long-term environmental, social and economic impacts. These could potentially form an important part of a certification scheme which would acknowledge environmentally responsible mining, enabling consumers to make similar decisions on their metal and mineral products.

Single-sourcing of a metal is thought to be unique for a modern copper roof and opens up the debate on the feasibility of certification schemes for metals. From this exercise it was apparent that there is no definitive prescriptive mechanism for determining what is the most sustainable material. By introducing the notion of tracing a metal from its source, we feel that this can only enrich the Envest system.

The Eden Project has just begun a two-year research project that investigates the barriers to the development of co-ordinated minerals supply chain stewardship and a key focus of this will be on its potential in the construction industry.

## Further information

Rio Tinto [www.riotinto.com](http://www.riotinto.com)

Kennecott Utah Copper [www.kennecott.com](http://www.kennecott.com)

Building Research Establishment (BRE) [www.bre.co.uk](http://www.bre.co.uk)

Nicholas Grimshaw Architects [www.grimshaw-architects.com](http://www.grimshaw-architects.com)

KM Europa Metal (KME) [www.kme.de](http://www.kme.de)

Copper environmental profile [www.kennecott.com/pdf/Copper\\_Environmental\\_Profile\\_Declaration.pdf](http://www.kennecott.com/pdf/Copper_Environmental_Profile_Declaration.pdf)

Mineral Supply Chain Stewardship project [www.edenproject.com/mineralstewardship](http://www.edenproject.com/mineralstewardship)

Waste Neutral [www.edenproject.com/wasteneutral](http://www.edenproject.com/wasteneutral)

