

Fantastic Ferrocement

for

Practical, Permanent Elven Architecture,
Follies, Fairy Gardens and other
Virtuous Ventures

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Fantastic **Ferrocement**

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Introduction

This book is mostly about the joy of ferrocement as a medium for the creation of durable beauty. The joy of having a concrete means to realise beautiful dreams that would otherwise be impossible without frightening amounts of money. Dreams of natural shapes, fantastical, whimsical, inspirational, sublime. Fountains, domes, follies, grottos, garden borders, birdbaths, ponds, pots, sculptures, steps, bridges, boats, towers....

The joy of ferrocement, like all joys, takes a little knowledge, provided here, but mostly just the courage to actually, physically try it. Your very first try can be useable, beautiful and above all a bridge to all the other possibilities that will suddenly open up to you when you realise how easy it is.

I hope you will use this book to build *your* bridge from the irrational 'I can't, because I never have,' to the triumphant 'I can, because I just did!'

'Just do it' is a very wise saying, cutting through so much junk thought! There are so many skills I thought for years would be too hard to try, until I finally just tried them. Then they suddenly seemed easy—from then on it was just a matter of practice.

This is a beginner's progress scale for the skill of ferrocement:

1. Buy this book. Congratulations! You're halfway there. (Plus, you have helped fund the building of Dreamspace, the ferrocement fairyland of inspiration dedicated to Beauty, Truth, Love, and Freedom!)
2. Buy the materials and a few tools if you don't already have them; you're 80% there.
3. Make a shape with the wire; you're 90% there.
4. Mix your plaster and plaster it onto your shape. Fantastic! You're 99% there.

Now you know how to do it, you'll be able to do it again any time. It's like riding a bike, and you'll get better at it every time, 100% guaranteed!

1 Origins

The first recorded use of ferrocement was by a country gentleman, Jean-Louis Lambot, who built a little ferrocement rowing boat in 1848. In a book I read in 1969 there was a photo of this pretty little boat—it was still in use on a lake. Lambot patented the method and planned bridges and other structures.

In 1849 a gardener, apparently working independently, used ferrocement to build flowerpots and, later on, garden furniture.

In the sixties and seventies there were a lot of ferrocement boats built, some very good ones professionally, in New Zealand. There was one plasterer in Whangarei who tells me his firm plastered over 400 boats! But there were many not so well done, and these gave the method a bad name. The main culprit was air pockets leading to rust and cracking of the hull. And the lighter, quicker-to-build fibreglass took over. It is a pity, as the chemicals used in fibreglass are not nice.

My own experiences: from ferrocement submarines and showers to Dreamspace and Café Eutopia

When I was a boy I read about ferrocement keelers and dreamed of building one. Then I forgot the dream until I went diving one day with a friend. I was entranced by the beauty of the undersea world, while nearly drowning through

the snorkel, so I thought: 'Why not build a little ferrocement submarine?' Partly with this dream in mind, I left school and began building it in my parent's garage, but lack of money and practical knowledge, added to the distractions of being a teenager seeking the Meaning of Life, the Universe and Everything, meant that the rusting skeleton of the ferrocement dream was abandoned.

Submarines have to meet some very stringent requirements, which lie outside the scope of this book. Nearly everything else is a push-over in comparison. Still, it was many years before I got back into ferrocement. This time I was studying philosophy in Auckland, and we had just bought an old bungalow. It had no shower, and we were strapped for cash, so I decided to build one, and ferrocement sprang to mind. Despite Raewyn's misgivings, I went ahead. The results were quick and permanent. It was a pity I didn't bother to get some reinforcing rod—the chicken wire was a bit saggy, so we ended up with a wavy-walled shower. But it was good for singing in, and very, very strong. We found that we had built not only a comforting shower but also a reassuring earthquake shelter.

Then there was the think tank, my philosophy study for deep thought and escape from dogs, cats and young children. It was a seven foot geodesic sphere made of plywood triangles stapled together and sealed. It was great, but kept leaking until I plastered it and made a ferrocement vent on top, like a ship's ventilation funnel. The layer of concrete, though only about 2 cm thick, cut the noise right down and kept the rain out. The sphere has since been moved with us (by hiab truck), several times, and is now nearly fourteen, and sits outside Café Eutopia. It has been a jewellery workshop, an

icon-sphere, an office for our recycled tyre pot business, then later the café office.

After two spheres, I decided the most ergonomic shape that still had the virtues of the sphere was the beehive—a hemisphere sitting on a vertical wall. And in the back garden behind a drystone wall overgrown with roses, the fairy garden we called it, I built, on a very tight shoestring, a seven-foot dome of old brick with a fibre-reinforced cement for the domed roof.

This led to the next phase, when we had moved out of Auckland, the philosophy studies over. We were sick of the infill housing and Raewyn had run out of garden space and yearned for an orchard as well, and a view of the sea, and a place for our children to bring our grandchildren into the world.

Thanks to my next project, it was to be years before we made this happen. Café Eutopia and Dreamspace (see vision-illustration) was, and is, a dream which grew in the making. The vision is to create a Camelot-like walled space of inspiring beauty and organic form, with a café-restaurant with domes, a fountain, a round table, a tower and a labyrinth, as well as rooms in the cloister walls for backpackers or a bazaar, and terraced herb gardens.

It all started in the 'little town of lights,' Kaiwaka, Northland, on State Highway One, just over the bridge, when I saw a glowing triangle of long green Kikuyu grass. We were visiting to look at a peninsular on the harbour which was later to become Otamatea Ecovillage. We didn't buy into the Ecovillage in the end, but the triangle of glowing green Kikuyu came up for sale some time later, and we bought it. I

was compelled by a vision close to falling in love; Raewyn was compelled by a love for me close to martyrdom.

Our youngest daughter Xanthe said the field was like the Field of Dreams in the film by that name, and that is what we called it, not knowing what exactly it was for, but trusting that something beautiful would happen. We scythed the Kikuyu and Raewyn planted herbs and flowers, and I experimented with turning old tyres inside out to make big garden pots to keep the kikuyu at bay, When I painted the pots, they suddenly became a hot seller.

So *Entyrelly Recycled* was born, yet another big stepping-stone and detour for me when I insisted, against Raewyn's better judgement, to move it to Auckland. There I lived a 'parallel life' with Raewyn, and *Entyrelly Recycled* struggled with overheads, imports, bookwork and freight costs as I struggled to perfect the technique for converting the mountain of old tyres into beautiful painted pots. When I finally sold the business (at a loss) and came back to Raewyn and the Field of Dreams, a wiser man, I nevertheless knew that the original dream of domes still needed to be acted upon. But there were many inner resistances to be overcome. Still, being in Auckland I had been available to write for my brother John at Greenstone Pictures, and we had embarked on some wonderful fantasy adventure stories.

Also, I had done a workshop for finding your life purpose, called Lifework, started by an enterprising antipodean fairy woman, and there I had realised I was indeed a 'wizard' (which I had known all along—as one always does, deep down) and that I had neglected the divine feminine, and needed to return to Raewyn and Kaiwaka and the main purpose of my life, though it was still veiled.

Then one day I was taking our eldest daughter, Anna, back to med school. We stopped at the Dome café (which is not a dome, but overlooks Dome Valley). She said, 'I've always wanted to have a little café one day,' and suddenly a light went off. I saw that before making domes for sale, as I had been planning, but was stopped by my perfectionism, I could build a little domed cafe, on the Field of Dreams. And she said, 'If you build it, I will come,' or words to that effect.

So, applying the decisive 'just do it' approach which we had just learned at the Landmark 'Forum', combined with a mystical faith in the universal process, we declared our intention to not just dream this idea, but do it. I vowed to try to build the café dome for her before she came up again at the end of the term. I began, and she took the year off med school. When she arrived back at the end of term I hadn't finished it; only the foundations had been laid and a building consent got, but she got stuck in and helped. By now the plan was for five domes, one for the kitchen and four for customers to sit in.

We didn't know much about building, but we began to learn, the hard way. Our main obstacle apart from lack of money was fear of the unknown, such as council red tape (a greatly exaggerated fear, it turned out), my perfectionism, and my shyness about doing such crazy stuff in full view of everyone in town and all the vehicles streaming noisily past the little field. It was a year of idealism, growth of the vision, agony and ecstasy. Raewyn was scared of what we were doing in full view of all the world, and imagined a ruin with the Kikuyu growing over it, and us bankrupt.

But several bank loans later, it was ready to open as a little dream café-in-progress. We wanted it to be organic, which took a lot, but we did it and Café Eutopia was born. Eutopia means Good Place in Greek, as opposed to Utopia which

means literally, 'Not a place,' somewhere fictional, a place assumed too perfect to exist in real life. We had a magical 'pre-opening' party, and some good friends we had met spoke of how the vision had found a place in their hearts and inspired them to help. Then, when we realised the full extent of the project and decided to accept it would be a work in progress for many moons to come, we held the main opening, and the good Mayor of Kaipara came and declared café Eutopia open, and there was dancing and celebration under the temporary tent where the Chartres labyrinth will one day be built.

The whole Big Vision, which I called Dreamspace, continues, the blueprint written on our minds and hearts, and some of it on paper. And batch by batch we plaster and carve and paint, as money and time permit. By acting on my deepest impulses and values, 'The jagged pieces of my life have come together to form a complete, mystical whole' (from Hook, the movie). I now see that whole as a temple to 'Beauty, Truth, Love and Freedom.' And as a sculpture of the Universe, and an embodiment of the marriage of Heaven and Earth, the marriage of opposites.

After Anna returned to med school, Raewyn nobly left Koanga Gardens where she had been working and took over the struggling little café, and I continued writing for my brother to make ends meet, and to convey something of my eutopian vision of how life can be. And if one day I write a best-seller, the rest of Dreamspace will be built, a fantasy in ferrocement, glass and wood, founded, like all Eutopias and Camelots and 'dreaming spires,' on visions written and woven over the years on the enchanted loom of the human mind, built on the good earth with sacrifice, love, and long hard labours.

Esoteric ferrocement

The symbolism of ferrocement is interesting. The uncrushable but brittle married to the bendable but unbreakable. A marriage of opposites. I had these impressions as we built Dreamspace: the wire framework is like the bones of the body; the chicken wire the muscle layers, and the plaster is the skin. Or, the wire framework which is woven together is like a spider's web, beautiful in its own right, ethereal, the wind whistling through it, but strong and supportive. Then there is a transformation, and that beauty is lost, but another is born: the beauty of the solid enclosing form. Then even that is transformed when it is carved and painted, losing its starkly beautiful bone-like look and gaining whatever colours our aesthetic sense dictates.

Esoteric, *frustrating* ferrocement

And the journey of building in ferrocement is a good exercise for would-be creators. It is a discipline of actually grounding a pure perfect beautiful heavenly idea in those two very stubborn and earthly materials, steel and concrete, hard and heavy, recalcitrant and messy. Sometimes as Anna and I laboured on the domes and arches of Dreamspace the steel got *very* rusty and poky and springy, and the concrete got *very* wet and cold, messy and abrasive, getting into all the cuts the steel had made, ruining clothes, and dropping off the mesh or sliding off trowels into gumboots, splattering tools and ladders with mud that turned surprisingly quickly to stuck-on stone. And just when we thought we were finished, we found we weren't; there was always another area to do or another coat to put on. Then the daylight always seemed to run out and we'd be cleaning up in the dark.

The need to keep the plastered areas wet for seven days was another trial of patience. Our lovely work hidden, covered in

ugly sacking and dripping with water from the hose, day after day. And if this was skimped, the plaster could dry too quickly and become less strong, and its future for all time be less secure.

In other words, doing ferrocement properly is like doing anything of a permanent nature properly. It takes knowledge, courage, patience, preparation, hard work, and faith in the value of the end result. So, what else is new?



2 What is possible?

Given the above heroic human qualities in large quantities, the sky's the limit. My vision is of a kind of renaissance culture—we are not far off it in many respects, here in New Zealand—which reverently yet exuberantly combines the best of old and new. Like all great cultures, it will need an architecture for every level. For homes, stone and earth and durable natural wood are good, but for sculpture and inspirational buildings in organic forms, ferrocement is perfect. It is a fraction of the price of stone, but plastered with an extra layer and carved it is a durable creative medium and can be safely formed into shapes impossible with stone, though the wonderful gothic cathedrals show what *can* be done even with nothing but stone and wood. But try getting a building consent for a gothic cathedral built of unreinforced stone! And getting a banker to finance it!

So far, over three years off and on, we have built five ferrocement domes joined with arches around a courtyard with a ferrocement fountain carved as a blue lotus, a part of the cloister wall, with pillars carved with two fairy-gnomes, and a moongate with a 6-metre guardian gull over it. And two ferrocement tables, one with a spiral support, the other carved with a picture of a man and woman, and the caption 'Live hand in hand, and together we'll stand, on the threshold of a dream.' (from the Moody Blues song). Most of the place still hasn't had its final coat of plaster which is to be carved then stained or painted. But good things take time.

Our next big push is a kitchen extension with a bar opening onto the Labyrinth circle, all in ferroceement. The engineers who did the calculations were intrigued but happy with the practicality of our plans. And if engineers are happy, and you take care with the actual construction, in our experience the building inspectors will be happy too. After all, the Sky Tower in Auckland is built of concrete! Our aims are so much more modest.

Is there a new type of ferroceement just around the corner? Could be, where the mesh is woven in situ, for example. Tiny robot weavers, for example, weaving the framework to a shape designed onscreen? It would still need bigger reinforcing, but maybe this could also be woven, like steel cable?



FIGURE 1 An early blueprint for Eutopia – lots more to do before it looks like this!

3 The Concept, Costs and Benefits of ferrocement

The concept of ferrocement

The idea is that if you impregnate a fine enough network of steel with a thin layer of cement plaster (that is, concrete without the gravel, just sand and cement), you get a very strong, flexible 'membrane' with the properties of both steel (Latin 'ferro-') and concrete; hence the name ferrocement. And because steel and concrete both expand and contract at the same rate, it doesn't crack easily with extremes of hot and cold weather; also the rich cement layer 'passivates' the steel, stopping it from rusting as long as there are no air pockets or cracks.

For small objects made of ferrocement, the steel network can be made of just the fine strands of reinforcing, but for bigger objects the idea is to create a fractal network of reinforcing, i.e., to have a coarse network of thick reinforcing, then a finer network of thinner reinforcing over it, then finer still, down to the finest.



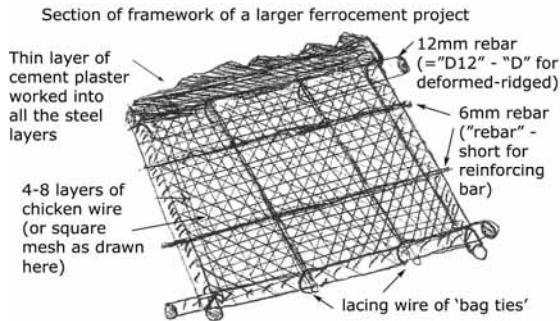


FIGURE 2 Section of framework for a medium-sized ferrocement object



Practical ferrocement technique - overview

There are many possible ways to achieve this steel-rich cement membrane, but typically, two to eight layers of standard galvanised 'chicken wire' (12mm mesh size) from a roll about one metre wide are tightly tied with thin wire onto both sides of a framework of reinforcing rods, then a strong cement plaster is trowelled or hand-smearred into it, in one or two coats. The mix is usually about 2:1 or 3:1 i.e., 2 or 3 containers of sand to one of cement, well mixed with water with a little plasticiser added for ease of working. The water is added until the mix is like porridge, not too thick or too thin. The right mix will be easy to push into the mesh layers, and ooze through the other side of the mesh like toothpaste, without slopping right out like runny porridge would. It is

hard to describe thickness, but you will soon get the feel of it. Experiment with small batches.

Variations: expanded steel mesh can be used, but it is not as good—the steel is too thick and the plaster can crack and peel off it. Welded square mesh, 12 mm mesh, can be used, but it is more expensive and can't be wrapped over curves that go both ways (e.g. a ball shape) like chicken wire can, and even on flat curves I have found it tends to buckle in and out when tied to the reinforcing framework.

What ferrocement is best for - a cost-benefit analysis of the method

The materials, thanks to modern knowledge, are really very cheap, for such a permanent strong building material. But if you are looking for the cheapest, this isn't it. Ferrocement is nowhere near as cheap or quick as four by twos and play and corrugated iron, for example. But if you are willing to do it yourself, and are determined to have curvaceous forms in a permanent material, ferrocement is for you, in fact there is hardly any (building-permittable) alternative.

Costing per square metre (NZ dollars) for a reasonably big object that needs 12mm reinforcing rods as well as 6mm:

12mm (D12) mild reinforcing rod crisscrossed to make a 500mm 'mesh': 4 m at \$1.16 = \$4.64

6mm mild steel rod crisscrossed to make a 200mm mesh: 25m at \$0.66 = \$16.65

12mm mesh galvanised chicken wire 900mm wide, four layers = 4.44 m at \$2.40 = \$10.65

Lacing wire to tie the chicken wire on: say 7 m at
 $\$0.07 = \0.49

Total steel cost: \$31.94

Plaster at average 20mm thick = 0.02 cubic metres,
less steel = 0.0138

Say 0.6 is Sand: at \$60/cubic metre = 50 cents

Say 0.4 is Cement at \$10/ bag = \$500/cubic metre =
\$2.76

Plus plasticiser at \$15/litre 5mls = say 10 cents

Total plaster cost = \$3.36

Total material cost for 20mm thick ferrocement panel:
\$35.30/square metre.

Or, if it needs only the chicken wire (for a small
item): \$14.01/square metre

This may seem cheap. But the labour content is high. For a
shape like a 2.5 metre dome of say 30 square metres of wall
and roof, not counting detailing like gutters, doors and
windows, just the flat surfaces:

12mm bars bent and tied in place: 4 hrs

6mm rod bent and tied in place: 16hrs

chicken wire cut and laced on: 24 hrs

plastered inside and out, first coat: 16 hrs

plastered, second coat if needed: 12 hrs

final coat sponged/rubbed/scraped 6 hrs

Total 78 hrs, divided by 30 square metres = 2.6 hrs/square metre, or say \$52 at a skilled worker's rate of \$20/hr (to do it at this speed and still do a good job, you would have to be skilled. Otherwise, triple it!).

And counting detailing and 'fiddly bits,' I would double it to say 5.2 hours/square metre. Plus all the designing and trial and error for one-off structures, say another 0.5 hours. And the second coat and brushing/scraping of the final coat, say 0.25 hrs. And the watering and checking, say 0.125

Grand Total labour 6.075 hrs per square metre. Round it off to 6hrs/square metre = \$120/square metre.

So, for total materials and labour for a single skin of ferrocement (if it is a building, it would need insulation and an inside layer as well) you are looking at about \$35.30 materials plus \$120 labour = \$155.30. Adding 5% for waste and costs like rubber gloves etc, say \$163/square metre.

So the completed shell of a 2.5 metre diameter dome (floor area 4.91 square metres) with two window openings and a door opening, without floor pad, and before painting, carving, etc, and installing windows and door, would cost \$4,890, or \$995.92/square metre. So, there are much cheaper ways to build a garden shed!

But if you are willing to do it all yourself, sacrificing the time and energy, the actual money outlay is much lower: \$1059 for a 2.5 metre dome, or \$215.68/square metre of floor.

And if you are sculpting small shapes or making large garden pots, for example, the cost is low compared to stone, the

result is probably stronger, and you can make shapes that would be impossible in stone.

Other pros and cons

Possible electromagnetic disturbances

Some green builders say living in a 'faraday cage' i.e. anything made of steel, is bad for us. I don't know enough to comment, but most ferrocement things are not made to be continuously lived in anyway. And if it is a problem for ferrocement, it is also a problem for a large number of people living and working in steel buildings, and driving in cars etc. If there is a danger, it is a low-level one, it seems. And just stepping out our front door is dangerous....

Environmental concerns

These are mainly about the amount of energy used in producing steel and cement, compared to other materials like wood. But we have to remember ferrocement is permanent so the cost is (almost) one-off. And there is actually very little material in a ferrocement structure, compared to, say, a cast concrete one.

And finally, it is not possible to create all these beautiful forms any other way, not permanently and with minimal chemical or heavy metal pollution. I think the high energy input, if the energy is hydro and not nuclear, is definitely worth it, to make human environments more beautiful and inspiring.

4 The Nitty-gritty: How to make fantastic ferrocement

If the last section has not put you off, you are obviously a seeker of lasting beauty and are willing to pay the price. Read on, kindred spirit!