Radical new 3D printed construction technology coming soon will change the look of engineered structures.

They may look like something from "The War of the Worlds" but these radically designed and constructed highway light towers may well represent the future of engineering.

Future Technology "free form" 3D printers coupled with sophisticated generative design software are set to transform engineering with ultra lightweight structures, 3D printed on-site.

What is a "free form" 3D printer?

Conventional 3D printers chop structures into cross-sectional layers with dedicated software. The printer then prints one layer at a time like a stack of pancakes, forming a 3D dimensional object. The technology used to produce the layers could be one of the many developed so far, but the principal of thin, stacked layers is the same.

A Free Form 3D printer such as in Branch Technology's system doesn't bother with layers. It deposits material into solid wires running in any direction. The wires form a 3D dimensional lattice or framework like the Eiffel Tower, except there is no human assembly work required.

What is generative design?

Generative design such as Autodesk's project Dream Catcher means that a computer program generates a design by performing a mathematical process over and over again (iteration). That process can be any geometrical function that takes a designers whim, as long as it results in an interesting object or pattern. Generative design software is of value to architects and artists due to its ability to produce beautiful forms.

From and engineers point of view the most valuable type of generative design software is called topological optimisation (T.O.). Topological optimisation software also uses mathematical processes but the formulas derive from complex engineering, physics and computer science. The result is a structure, which evolves on the computer screen before your eyes but which none the less, obeys the rules of physics and engineering. For example, a recognisable bridge with the familiar trusses and struts will simply evolve with this type of software. The user inputs nothing more than the loads to be carried, the external supports available (a wall or the ground) and the areas where structure is not allowed (voids).

T.O. structures often resemble bones, why? This is because evolution has evolved the skeleton to shape itself in response to gravity, stresses and loads. It is exactly analogous to T.O. software's design principles.

Why 3D print generatively designed structures?

The cost of construction weighs heavily on an engineers mind when she designs a project. Generatively designed structures often have complex non-uniform shapes and so would be very expensive to make in a conventional factory. 3D printing technology circumvents this limitation by doing away, not only with the factory but also any need for standardised materials.

What materials are used?

Branch Technology's system (see video above) uses extruded plastic filament. Other companies such as TRUMPF from Germany use a process called "Laser Deposition Welding". In this process powdered metal is sprayed onto an existing surface and then instantly melted with a high powered laser. MX3D in the Netherlands has also developed free form 3D metal printing using more conventional welding technology and plans to use their equipment to 3D print a steel bridge in Amsterdam.

Problems to be overcome.

The main obstacle to the wide adoption of Free form 3D printers in construction is the build speed of existing machines. The additive deposition of a wire of plastic or metal takes time and must be speeded up. That said, it's a fair bet that future technology will greatly speed up the process resulting in a stunning revolution in engineering and construction.

Want to try this future technology for yourself? It's easy, here's how.

Step One: - Find free Topological Optimisation Software

After a brief Internet search I downloaded a free program called TopOpt3D written by a research group at the Technical University of Denmark.

Step Two: - Figure out how to use it

A click on the help button brings up a surprisingly brief PDF document, which includes two quick tutorials to work through. After maybe an hour I was able to begin designing my own structures. Basically the user only needs to input the loads to be carried, the external supports available (a wall or the ground) and

the areas where structure is not allowed (voids). You simply have to position these zones where you want them.

Step Three: - What are you going to make?

I was after an example structure, which demonstrates how the program evolves structures that are distinctively organic and yet technically valid. After a few tries I settled on the lamppost project.

Step Four: - Set up zones of load, external support and voids.

For the lamppost, the load obviously is the light itself. The external support is a small patch of solid ground with a concrete foundation pad. And the void zone is all the area between the light fitting and the road because the light path to the road surface must be unobstructed.

Step Five: - Tweaking your design

Making small adjustments to the position of your zones and watching the effect on your structure is all part of the fun. The other major variable is when to stop the evolution of your design. The program will run endlessly, but after a minute or so the structure stops evolving, presumably this is the optimum design. I chose to stop a little before the end point because I liked the shape. (Artistic license)

Going Further: - Import your design into a 3D Computer Graphics program

If you haven't yet learned to drive a 3D Computer Graphics program let me tell you, it's a lot of fun! A little patience and you can draw and realistically render anything you can imagine. Designing your own 3D printed objects is totally do-able. You will need maybe a couple of months of one hour sessions daily plus plenty of perseverance, but imagine being able to make anything you want just by drawing it! The software I use is called Blender 3D. It's free, open source and constantly improving. Blender isn't the easiest 3D graphics program to learn but it's capabilities are vast and the effort is worth it.