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Consider the word *assembly* for a moment. It has several meanings but one, as a noun, is the coming together of separate parts into a single mechanism or product. How do you make an assembly? You *assemble* it of course, so that's the verb – to assemble. Some things you can make or buy are assemblies, some aren't: a coffee mug is usually just a single part; a coffee maker generally has several. One version of the history of invention, design and manufacture could be written purely from the perspective of assembly. The oldest-known tool -- the hand axe, a palm-size rock chipped into a useful shape – was eventually improved upon by the addition of a wooden handle, enabling the sharp rocky bit to be accelerated to a high speed, thus multiplying the energy of the impact. And when I say *eventually* improved, the pace of innovation back then was such that it was well over a million years before the Edison of his day had the idea. That most iconic invention, the wheel, can be interpreted as the development of a bunch of loose parts (a plank and some rollers) into a single assembly (a plank, two axles and four wheels).

The idea that to make useful things you assemble bits together seems obvious, a no-brainer. Most of the things we own and use are assembled from parts (mugs, $10 chairs and windshield scrapers notwithstanding) and we accept that this is how manufacturing works, it's what happens in factories, parts are made and then they're put together, to make scissors, sofas and Sony Ericsson phones.

Assemblies can be optimized: as products get ever more complex, it makes sense to find ways to *integrate* parts, reduce today's bitty sub-assembly, a latch for example, into tomorrow's delightful and intelligent *single part.* Parts reduction is a good strategy and the rise and rise of plastics has made function integration with parts reduction an effective strategy and an exciting challenge for designers. But even with lots of clever, functionally integrated parts, most products are complex assemblies; some – like cars – are extremely complex. Complex, but also clever and ingenious with pretty efficient use of product volume and materials.

Assembly, though, is far from efficient when it comes to manufacturing space and energy; it takes a great deal of both to make even relatively small products in any volume. A playing card-size phone has parts made using heat and pressure in several large factories, then shipped in trucks to an assembly site where young women in dustproof overalls and facemasks click and screw them together. This takes acres of space and many miles of transportation all told. A car, an object just two paces by four or five in plan, requires hangar-size parts manufacture and assembly buildings on town-size campuses. So the parts-and-assembly idea, probably born

around the time the stone axe acquired its handle, works okay but seems to require huge investments in energy, time and space if the kinds of production volumes required are to be met.

Nature makes products in high volumes across a range of scales. Even some of the smaller products – a cat, say – are far more complex in their systems and structures than a car, yet they are ‘manufactured’ in a very small footprint (mother cat) and with a modest amount of energy and material (a few sacks of KittyCrunch). Of course Nature doesn’t do assembly; it *grows* things. We can grow products too, in our own fashion, up to a point. We call our growing process rapid manufacturing (RM for short) and use digitally controlled machines to build up parts layer-by-layer. There are many competing techniques, using laser or electron beam energy to fuse plastic, metal or ceramic materials, but the principal is always the same: data in – part out, all within the footprint of a ‘magic cabinet’. Right now only single material parts can be made this way, but there’s a compelling need for multi-material ‘assemblies’ so that’s the Holy Grail of process R&D. As one RM researcher told me, there’s nothing in the physics or chemistry that says you can’t do it.

Imagine designing for a product that’s ‘grown’ rather than assembled. Would that change the design? Mechanically? Visually? Of course it would, and it will.

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