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a brave new world

The year is 2020. Materials and manufacturing technologies came a long way in the last century, but in the past two decades, the advancements have truly liberated the industrial designer. In particular, there have been significant strides taken in tool making, processing equipment and high-performance resins.

Let's review the radical developments of the past 25 years and look at four examples of their application.



The Lawn Tank, a lightweight, self-powered, non-polluting lawn mower, embodies all the most recent material developments of the 21st century.

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Pressure to decrease tooling lead times inspired companies to experiment with stereolithography technology in mold making.

For processing equipment, more design controls and modularity improved quality and manufacturing flexibility.

The development of experimental grades of resins with properties ranging from conductivity to light emission to very high temperature resistance. New, water-thin thermoplastic cyclic polyester reactive resins revolutionized very large low-pressure composite molding.

As military and aerospace markets dwindled, composite manufacturing methods found commercial markets. New materials and reinforcements translated into more cost-effective manufacturing processes. Composite metals, plastics and ceramics improved product design while combinations of lightweight carbon and boron fibers with plastics yielded materials with physical properties unmatched by any natural material. Processes such as resin transfer molding and pultrusion eliminated much of the labor associated with composites.

To improve overall performance, coating materials ranging from sand to diamonds were combined with different substrate materials through innovative techniques such as vacuum deposition, microwave plasma deposition, sputtering, arc spray coating and ion implantation. The result improved hardness, scratch resistance, corrosion resis-

tance, sound absorption, multiple colors, abrasion resistance and biochemical compatibility.

The demand for high-performance materials in semiconductors, insulators and high-temperature materials led to the refinement of ceramic materials and manufacturing processes.

Improvements in processing resulted in ceramics derived from silicon nitride and boron nitride, which were coextruded within a polyethylene copolymer compound. The resulting filaments were sintered into extremely strong materials used as reinforcements for metals and plastics.

Other processing methods included gel casting and sintering, but the most exciting innovations came out of the discovery in 1986 that a metal oxide rather than pure metal could be used to achieve superconductivity at much higher temperatures than thought possible. This, and subsequent compounds based on yttrium barium cuprate, paved the way for smaller and more efficient motors and electronic devices.

These new materials and processes also led to the refinement of free-form fabrication technology, which was commercially introduced in 1987 with the presentation of stereolithography. The new century brought new techniques based on the use of different plastics, metal powders, ceramics and even composites to expand the size and selection of parts. Other methods included solid ground curing, selective laser



The Sontex wall-mounted home computer, introduced in 1988, features a variety of coatings, each for a specific purpose.

sintering, laminated object manufacturing, design-controlled automated fabrication, solid creation system, solid object ultraviolet laser plotting, ballistic particle manufacturing, printed computer tomography, shape melting and three-dimensional printing.

Products quickly incorporated this new knowledge to the point where free-form fabrication was routinely used in everything from appliances to replacement human body parts. Although the laser is common to all variations, materials and techniques vary widely. No longer are industrial designers limited to one material or solid walled shapes.

To illustrate the paradigm shift that has resulted as these innovations opened new doors, let's look at four 21st-century products.

In 2015, KTX Associates introduced the The Lawn Tank, the first self-powered robot lawn mower. This design expressed innovative

use of material and manufacturing breakthroughs. The design team cleverly interpreted the mower with features common to military tanks. This reference suggested durability and provided functional benefits. Low-profile electric motors of superconductive ceramic coils contribute to the low-profile appearance and high operating efficiency. One motor drives the rotor while the two stepper motors govern the mower. Built-in sensors guide the device around the lawn.

An exterior photosensitive coating converts sunlight to electric energy, and batteries based on lead-coated glass mats form a recyclable plastic module, which continually recharges. This honeycombed modular structure of carbon-reinforced nylon 6/6 acts as a support bridge. Designers used Helisys-laminated object manufacturing methods to form these complex shapes. Composite graphite/polyester molding compounds result in a lightweight, rigid deck. ▶



Magna's ultrasonic clothes washer shows what industrial designers can do given the new materials capabilities of the 21st century. Composites, protective scratch resistant coatings and ceramics allowed Magna's designers to consider nontraditional forms for a product that has remained virtually unchanged for the past 80 years.

Instant success greeted the wall-hung home computer from Sontex in 2018. Its industrial design teams redefined the computer to integrate with electrical devices throughout the home. Operated by voice or touch, the unit uses infrared and spread spectrum technology to communicate with or replace peripherals such as televisions, stereos, telephones, timers and surveillance equipment.

**The lightweight, thin curved form features a variety of coatings, each for a specific purpose.** Polyaniline, for example, renders certain sections as displays, controls and keypads, and photosensi-

tive silicon converts light into electric power. Sontex's solid creation system formed the smart composite modules that can be plugged into the main body for added functionality. Microchips and circuitry are directly implanted into the main body of the computer. The unit's high efficiency and solar-powered coatings let it run indefinitely on long-life batteries.

Magna introduced the ultrasonic clothes washer in 2012, a major departure from the bulky washers of the previous 80 years. Its piezoelectric spheres "wash" clothes by shaking off all dirt, using less than two gallons of water and special

detergents. The same ultrasonic energy dries clothes after pumping out excess dirty water. By eliminating a rotary wash basin, the design team could achieve a flatter, more compact shape. Composite materials give the compact washer rigidity, light weight and free forms not easily achieved with stamped steel. **A thermo-plastic elastomeric gasket forms a watertight seal all around the front door, which features polyaniline LED coatings to let users program the washing conditions.** A diamond-coated polycarbonate blow-molded door permits total access to the wash chamber while providing a watertight seal and high visibility.

Lightweight, portable and durable were some of the adjectives for a table saw introduced by SaWell in 2012. The Alpha power tool division creatively applied new materials and manufacturing processes to a lightweight portable table saw that redefined design for the power tool industry by replacing massive and bulky forms with efficient shapes.

The saw's highly efficient compact 5 hp motor, made possible by superconductive wires, shares a tiltable housing with the saw blade. A stepper motor drive system controls blade tilt from a front control panel that uses an electroluminescent display. Built-in rotary and linear capacitive sensors determine precise blade angle and fence distance. Boron nitride rods embedded in a clear, diamond-coated polycarbon-

ate leaf provide a very rigid lightweight surface. Fold-down panels, created in three-dimensional printing technology pioneered by MIT in the 1990s, and double-shot injection-molded foldout legs, molded in bright colors around a carbon-graphite core, provide rigidity, light weight and strength. Visually bold and colorful rubber feet dampen vibration and add stability during use. The unit folds into a 4" thick case for easy transport.

This brief glimpse of major developments in materials and processes during the past 25 years offers insight into the creative designs introduced by industrial designers who took advantage of the technology.

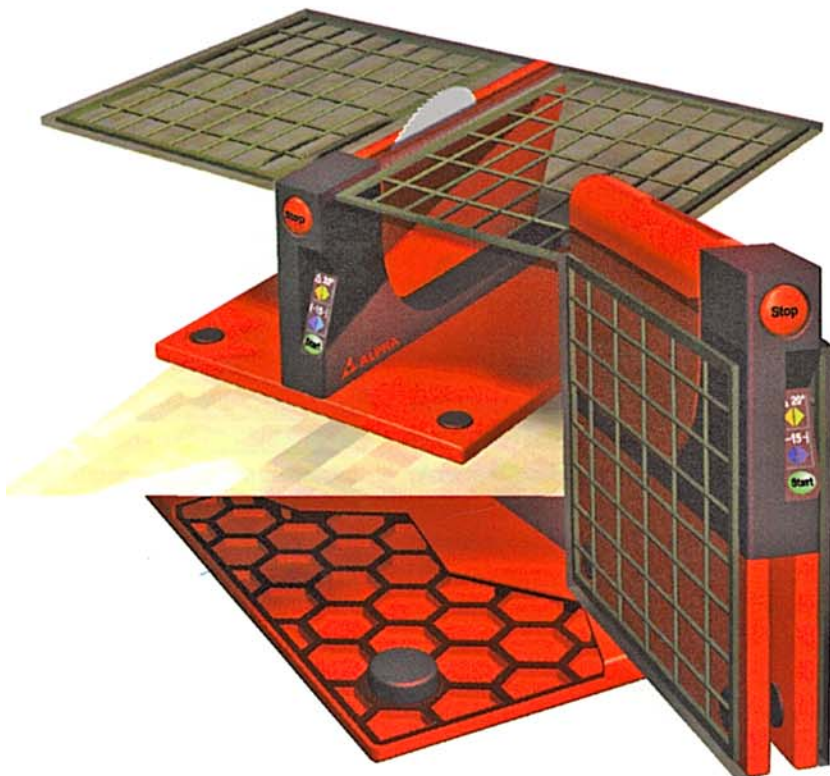
What do we have to look forward to? Within the next 25 years, we may be genetically designing products, colonizing distant planets and living under the sea.

Industrial designers can look forward to a time when products will have no specific top and bottom orientation. We will design for a three-dimensional environment where ecosystems, materials, societies and life will be carefully managed in order to sustain themselves. **New materials will be fabricated in weightless environments from solar energy.** Living organisms may be designed to work in conjunction with inorganic objects as a routine part of our exciting designs.

The only limit is our imagination! ■

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SaWell's portable 10" table saw set a new trend for the company as well as the industry. This radical new design is made possible by new composites and coatings.