TECHNOLOGY

Big Demand for Tiny Gadgets

Miniaturization, once largely a novelty, is now the basis for a flourishing new industry. Tiny devices are meeting the expanding needs of today, David Meier reports.

➤ THE SPECTACULAR GROWTH of a dynamic technological application called miniaturization is causing larger and larger segments of American "Big Business" to start thinking smaller and smaller.

While satellites whirl into orbit and automated factories spring to humming activity, demands keep increasing for tiny, efficient, reliable equipment to cut down the bulk of space-probe payloads and keep a factory's electronic "brain" from growing larger than the machines it controls.

Miniaturization, once a patience-trying plaything for artists and craftsmen who painted a portrait with a single sable hair or carved the Lord's Prayer on the head of a pin, has come into its own. It may, in fact, be the focal point for a "second industrial revolution."

Miniaturization enabled the United States to orbit lightweight satellites with data communications systems that out-perform those in the heavier Russian satellites.

It is the key to steady advances in the capabilities of electronic computers. It may revolutionize medical sciences by giving the surgeon and the diagnostician amazing new tools and tracking devices. It could open up vast new markets for products aimed at the rank-and-file consumer.

The rapid pace of miniaturization developments accelerated in 1948, when the hot, bulky, fragile vacuum tube, vital to electronic devices, gave way to the transistor.

Since then, the very term "miniaturization" has been changing to keep up with new trends and concepts. We now have subminiaturization, ultraminiaturization and microminiaturization, depending on the amount of shrinkage attained for each component or gadget involved.

The U. S. defense and space exploration program gave miniaturization its biggest boost.

Less Fuel Needed

The reasons are simple and extremely practical. The less that missile equipment weighs, the less fuel is required to launch it. The necessary fuel load can be reduced by as much as 100 pounds for every one-pound reduction in the weight of the equipment.

Even with lessened weight, fuel requirements are formidable, both for satellite-launching missiles and for tactical missiles used as war weapons. Tactical missiles with explosive payloads must include not only the hardware that operates the rocket, but navigational and radio equipment as well.

Miniaturization is also important to ground forces. Lt. Gen. Arthur G. Trudeau, the U. S. Army's research and development chief, points out that "the implications of a ten-to-one weight reduction are important in the extreme" to soldiers and Marines who man-pack most of their weapons and equipment.

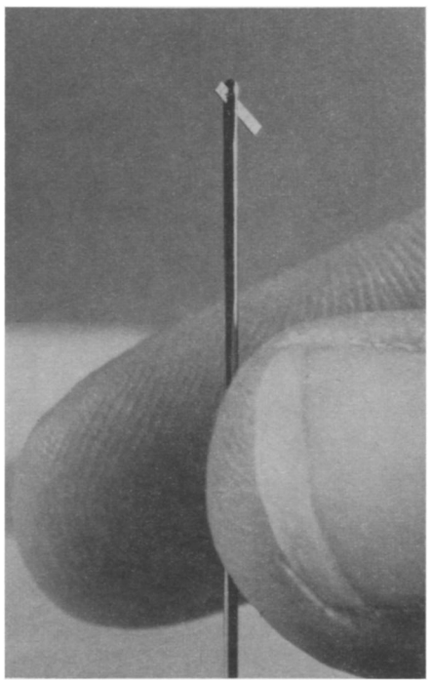
Progress is being made. The standard radio pack used in World War II, for instance, has been reduced from 40 pounds to 15 pounds, and may be down to five pounds by 1965. Far more phenomenal is the predicted three-pound weight by 1965 for the Army's radio replay multiplexer, which transmits several messages simultaneously. The unit used during the Korean war weighed 1,200 pounds.

Brief Case Computer

An electronic computer so small that it fits into a brief case is seen as a possibility by one of the companies making computers for business and industrial use. Data-processing equipment of the future may have miniaturized memory storage elements with "colossal capacities," the manufacturers say.

The tiny components are getting matching microcircuitry. New circuit-building methods are being reported almost daily.

Miniaturized mechanical parts, as well as electronics devices, are getting increasing use. Miniature air cylinders, valves, manifolds and related equipment help conserve space in automated factories. Miniature ball bearings not much larger than the period at the end of this sentence are being used in gyroscopes, automatic pilots, electrocardiographs, anemometers and high-speed dental drills.



IN A NEEDLE'S EYE—Miniaturized logic element for use in electronic computers fits into the eye of a sewing needle. It was developed by Radio Corporation of America (RCA) Laboratories.

Medical applications of miniaturization are considered particularly promising. Doctors envisage a battery-powered television system, small enough to be swallowed, transmitting an "on the spot" pictorial report from a patient's stomach.

Already in use are an ingestible capsule that takes samples of stomach fluids, capsule transducer-transmitters that broadcast intestinal data, transmitters attached to teeth for studies of night grinding, and tiny probes to record the pulse, blood pressure, respiration and temperatures of astronauts.

A tiny instrument can be inserted into the heart through a vein in the arm, so that valve sounds can be heard from their source. Miniature electronic devices can be attached to the heart to supply a "beat" when the natural mechanism malfunctions. Miniature microphones, broadcasting to receivers the size of a cigarette package, may soon be used by doctors and the patients themselves to monitor heart activity.

Dental Drill Bearings

Tiny ball bearings assure the smooth operation of ultra-fast, painless, air-turbine dental drills with a speed of 250,000 or more revolutions a minute.

Miniaturization may allow one nurse to check the condition of dozens of hospital patients. Electronic skin thermometers could be connected to a central bank of indicator alarms, setting off an individual alarm if a patient's temperature changes radically. Miniature TV cameras would supply a look at each patient from the monitoring room.

Through transistor radios, camera equipment, tape recorders, tiny light bulbs and thumbnail-sized hearing aids, the consumer has become acquainted with the day-to-day potential of new miniaturized products. But there is reason to believe that the surface has not even been scratched.

A truly portable TV set and a two-way wrist radio are among the fascinating "things to come" in the consumer-market field. So are miniaturized electronic controls for automobiles, capable of maintaining highway speed, slowing the car to avoid obstacles, and stopping it in dangerous situations.

Despite the seemingly limitless possibilities, all is not sunshine, roses and fat profits for the manufacturer who goes in for miniaturization.

As things now stand, the smaller the item gets, the bigger the cost and the ultimate selling price must be. One producer has stated that a so-called "miniature" product justifies a 10% price raise over the normal-size version, a "subminiature" model calls

for a 25% to 50% hike, and a "micro-miniature" model can sell for as much as 100% more than the original.

Much of the production machinery must be especially designed, at least at the outset. Some firms have to build their own. Whole new plants may be required to eliminate dust, vibration and temperature variation.

Raw material costs are high for top-quality, long-life metals. The vacuum-melt steel used in miniature ball bearings, for instance, sells for $5.67 a pound, compared to 24¢ a pound for ordinary cold-rolled steel.

Since miniaturization is a relatively new endeavor, companies often have to train their own experts. Production workers, too, need careful training.

Final assembly of very high precision parts may have to be done in sealed areas with air filtered to remove minute particles of dust. A complete absence of sunlight keeps heat from expanding the parts. Components must be handled with rubber gloves or tweezers to keep perspiration from corroding them.

Inspection and quality control expenditures run from 20% to 30% of manufacturing costs. The rigid requirements for much of the equipment necessitate costly testing and a high percentage of waste.

Big profits are possible, however, and the opportunities are many and varied. The future is particularly bright for the manufacturer who can find new, economical ways of shrinking some part of a partially miniaturized product that still remains "unshrunk."

Man himself is the greatest known example of miniaturized efficiency, notes Horace D. Gilbert, president of Miniature Precision Bearings, Inc., Keene, N. H. A computer expert has described the human body as a ten-cycle computer in a one-tenth of a ton chassis with a one-tenth of one horsepower motor.

The number of elements inside the skull's bone box are infinitely greater than the number in the most advanced computers. Their microscopic size enables them to function so efficiently within such a small space.

"Is it not conceivable that someday man might create a computer as complex and as complete and as small as the human brain?" Mr. Gilbert asks. "Perhaps not, but the goal to aim at is there for us, and we now are on the trail in pursuit of it."

• Science News Letter, 80:90 August 5, 1961

INVENTION

Patents of the Week

Improved method makes diamonds from piles of discs under high pressures and temperatures. A device for locating crashed aircraft invented in Spain.

➤ AN IMPROVED METHOD for controlled "growing" of diamonds has been patented by Harold P. Bovenkerk, Saratoga, N. Y., who assigned rights to patent No. 2,992,900 to General Electric Company.

The Bovenkerk system is said to produce "superior individual diamond crystals." Discs of non-diamond carbon material, such as graphite, and discs of various metal alloys, serving as catalysts, are stacked alternately in a new type of reaction chamber. When high pressures and high temperatures are applied, the carbon changes to diamond form.

Mr. Bovenkerk indicated that the best results were achieved when the alloy was made from an elemental catalyst metal combined with one of the strong carbide-forming elements, such as titanium, zirconium, boron, silicon, iron, manganese and tungsten. The melting point of the alloys is lowered, and the diamond-producing catalytic reaction increases. Why this happens "is not understood at the present time," he said.

He said "true diamonds" that passed standard tests for quality and density were obtained. The method reportedly improves on previous techniques of "growing" diamonds in cluster formation, which may inhibit growth of individual diamonds and cause surface irregularities.

A device to enable rescue parties to detect and locate crashed aircraft has been invented by Karl Edmund Devantier, Madrid, Spain, for which he was awarded patent No. 2,992,793. Planes would be equipped with battery-operated radio equipment in a small projectile, which would be catapulted automatically from the rudder tail unit at the moment of impact. The radio, protected by shock absorbers, would start emitting signals immediately, and would be parachuted to the ground or water near the crash scene.

Another invention was an improved method of converting salt water into fresh water. Norman D. Greene and Heinz F. Poppendiek, La Jolla, Calif., assigned rights to patent No. 2,992,977 to General Dynamics Corporation, San Diego, Calif.

The method used is thermal distillation, with the saline water first heated to vaporization temperature and the vapor then boiled off and condensed to pure water. Instead of the standard duct flow for the saline water, however, a whirling vortex flow is employed, producing much higher heat transfer and evaporation rates.

This, the inventors point out, makes their method more economical by heating the saline water faster, lessening the area of heat transfer surfaces, and greatly reducing the accumulation of salty crusts inside the boilers.

A simple, low-cost magnetic impulse motor, powered by batteries, has been invented by Lee Devol, Dayton, Ohio. Movement between coils and a circle of permanent magnets ceases immediately if the motor stalls, permitting use of the motor for the winding of watches or clocks without danger to the mainsprings. The motor also is adaptable to miniaturization, Mr. Devol said. Rights to patent No. 2,993,159 were assigned to Hamilton Watch Company, Lancaster, Pa.

• Science News Letter, 80:91 August 5, 1961

AERONAUTICS

Jet Pilots Told How to Reduce Take-off Noise

➤ TO CUT THE NOISE from jet aircraft operating near residential areas, pilots have been advised to get the plane up as high as possible on take-off, then to reduce engine power as much as possible while flying over homes.

The counsel came from the International Air Transport Association, Montreal, Canada. Their technical committee approved recommendations offered by a study group of noise abatement experts.

The take-off climb should reach at least 1,500 feet, and normal climb power should not be resumed below 2,000 feet or until the plane is past inhabited areas, the Association said. Above 3,000 feet, however, the pilot should forget about noise abatement and concentrate on adhering to the flight path.

On the ground, civil authorities should see to it that potentially noisy areas near airports are not zoned for home building.

Airport administrations were urged to help by establishing ground and navigation facilities to assure use of minimum-noise flight paths.

The Association said that compulsory restrictions on sound levels at given points and aircraft take-off weights, or changes in jet operational schedules, are not necessary. They believe such regulations would interfere with efficient airline operations and passenger services.

The recommendations were called "a practical guide to making airports good neighbors as well as community assets" by Sir William P. Hildred, the Association's director general.

• Science News Letter, 80:91 August 5, 1961

Questions

ANTHROPOLOGY—How long ago may man's earliest ancestor have lived on earth? p. 83.

ASTRONOMY—What earth satellites have been photographed for the first time? p. 82.

Photographs: Cover, Bell Telephone Laboratories; p. 83, National Geographic Society; p. 85, National Aeronautics and Space Administration; p. 87, Andrews Air Force Base; p. 90, Radio Corporation of America; p. 95, NASA; p. 96, Eastern Safety Equipment, Co., Inc.