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79-8

To

Sibil P Parker
Editor in Chief Encyclopedias
McGraw-Hill - New York

DATE 7/7/79 SUBJECT

FOLD

Dear Ms Parker;

Here is the copy for the encyclopedia. I've done extensive work on it to make it meaningful to your readers.

The facsimile materials I am using are from my own McGraw-Hill book, Techniques of Value Analysis and Engineering 2nd Ed. 1972.

I made the copies as I need them, thank you for your reply.

Sincerely,

L.D. Larry Miles

Prepared for the 5th Edition of The Enc. of Sci. + Tech. of McGraw Hill Co.

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Mr. Lawrence D. Miles
Sedgefield
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Easton, MD 21601

Dear Mr. Miles:

We are delighted that you will participate as a contributor to the 5th edition of the ENCYCLOPEDIA OF SCIENCE AND TECHNOLOGY as author of the article "Value engineering".

Enclosed with this letter are instructions, manuscript paper, and a copy of the "Value engineering" article from the previous edition of the Encyclopedia. While your article will be replacing this article, please feel free to use as much of the text as is still pertinent. In answer to your question, we do not require camera ready copy, and only ask that the material be typed double-spaced on manuscript paper. With regard to illustrations, we will add $10 to your honorarium to cover any copying fees you may have.

We will look forward to receiving your manuscript by the deadline of July 16. If you run into any problems or anticipate any unusual delay, please write or call me at (212) 997-4351 so that our editorial schedule is not seriously interrupted.

Sincerely,
Sybil Parker
Sybil P. Parker
Editor in Chief
Encyclopedias

SPP/ts
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~~ever precisely fulfilled. A term not so ambiguous is oxidation number or valence number. Oxidation numbers are useful for the balancing of oxidation-reduction equations, but they are not related simply to ordinary valences. Thus the valence of carbon in CH_4, $CHCl_3$, and CCl_4 is 4; oxidation numbers of carbon in these three substances are -4, $+2$, and $+4$. *See* OXIDATION-REDUCTION.~~

~~**Quantum theory of valence.** The above theory of valence is inadequate in at least three ways. First, it fails to account for many experimental facts, such as why the six C—C bonds in the molecule benzene, C_6H_6, are physically and chemically equivalent, what the electronic structures of the boron hydrides are, why the H—H bond is much stronger than the C—C bond, why CO_2 is a linear molecule but H_2O nonlinear, and what principles govern the rates of chemical combination. Second, the explanations that are offered are not physically satisfying. The stability conferred upon a molecule by the sharing of a pair of electrons by two atoms is established, but what is the real origin of this stability? And third, the theory is not comprehensive or quantitative enough to allow correlation and prediction of the many different properties of molecules. Dozens of properties of molecules can be measured, many to high accuracy. A theory should ultimately, and quantitatively, account for all of these. *See* MOLECULAR STRUCTURE AND SPECTRA.~~

~~The quantum theory of valence does not have these faults. It is based on the new precise laws of physics for the atomic domain which were formulated in the 1920s by E. Schrödinger and others, the discipline called quantum mechanics. The quantum ideas of M. Planck and N. Bohr require modification to take care of experimental observations that electrons and other particles at times act like waves. Like waves, they interfere when they are on top of one another in a manner that can be precisely calculated. According to 19th-century physics, an electron moving about a proton would collapse onto it. In the Bohr theory this collapse is prevented by a special quantum hypothesis; in the new mechanics it is prevented by elementary energy considerations. It would be favored by the attractive potential energy of the particle pair, but it turns out to be catastrophic for their kinetic energy. Instead of collapse a compromise is reached; the electron, or wave, is smudged out over a region about the nucleus which defines the atomic size. *See* QUANTUM MECHANICS; UNCERTAINTY PRINCIPLE.~~

~~The pattern of the periodic table comes out as before. The orbits of Bohr are replaced by new entities, orbitals, which represent not the paths of the electrons but the amplitudes of the electron waves at different points in space. Furthermore, electrons are treated as if they were spinning, but only in two possible ways. The rule that generates the periodic table then is that in an atom no two electrons can occupy the same atomic orbital with the same spin. *See* EXCLUSION PRINCIPLE.~~

~~In a chemical bond again there is interplay of kinetic and potential energies. An electron pair will tend to be shared by two atoms instead of being located on one of them if that situation is energetically favorable. The region between nuclei is more favorable for the potential energy of electron-nuclear attraction than other regions the same distance from just one nucleus. Moving in this restricted region is not as favorable for the kinetic energy as moving on individual atoms, but the potential energy predominates when a bond is formed. The normal covalent bond may be described as two electrons occupying one molecular orbital, rather than two distinct atomic orbitals, with opposite spins because the exclusion principle is still operative. *See* MOLECULAR ORBITAL THEORY.~~

~~When a detailed examination is made of these effects with the new theory, the stabilities of actual molecules and other of their properties can be quantitatively accounted for. In particular, if two atoms approach which have low-energy atomic orbitals which overlap each other in space, and if two electrons are available, the conditions are favorable for forming, with evolution of heat, a chemical bond. It follows that the valence of an atom is given by the number of unpaired electrons it possesses, an old basic rule of valence.~~

~~The greater the overlap between two atomic orbitals, the stronger the bond that can be formed with them (criterion of maximum overlapping). This condition may be regarded as determining the shapes of molecules. Two or more orbitals of comparable energy, as 2*s* and 2*p* orbitals, can be combined (hybridized) to give orbitals concentrated along certain directions in space, and these are the orbitals that participate in directed bond formation. In the carbon atom, for instance, the four electrons in the 2*s* and 2*p* subshells are potential valence electrons. The two 2*s* electrons are paired, however, so that to make four bonds possible one of these must be promoted to a vacant 2*p* orbital. Four bonds then are possible, in various directions. Four equivalent bonds can be formed, tetrahedrally directed, as in CH_4. Three bonds in a plane and one other less strong one can be formed, as in $CH_2{=}CH_2$. In this manner Linus Pauling and others have accounted for a multitude of phenomena in stereochemistry.~~

~~The peculiar binding in benzene and other aromatic molecules has been explained, together with its consequences for chemical reactivity. The principles governing reaction rates have been formulated and applied.~~

~~Research in valence theory through the 1930s and 1940s has led to understanding of a great deal of chemistry and it has contributed toward acceptance of the language of modern physics as a proper language for chemistry. However, considerable research in this field continues. New substances with new types of bonds are being synthesized constantly (for example, ferrocene, the first "molecular sandwich," in 1951). New physical methods for studying molecules are constantly revealing more intimate details of molecular structure which demand explanation (for example, the new techniques of magnetic resonance). Also, intensive work continues with applications of large digital electronic computing machines to problems of valence. Accurate determination of many properties of molecules containing only light atoms is presently being achieved by such computational methods. *See* CHELATION; CHEMICAL STRUCTURES; CONJUGATION AND HYPERCONJUGA-~~

~~TION; COORDINATION CHEMISTRY; CRYSTAL FIELD THEORY; KINETICS, CHEMICAL; MAGNETIC RESONANCE; ORGANIC CHEMISTRY; ORGANOMETALLIC COMPOUND; RESONANCE (MOLECULAR STRUCTURE); STEREOCHEMISTRY. [ROBERT G. PARR]~~

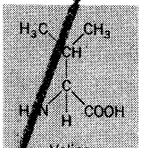
~~*Bibliography*: Chemical Bond Approach Project, *Chemical Systems*, 1965; A. L. Companion, *Chemical Bonding*, 1964; C. A. Coulson, *Valence*, 2d ed., 1962; H. Gray, *Electrons and Chemical Bonding*, 1964; L. Pauling, *General Chemistry*, 2d ed., 1956; L. Pauling, *The Nature of the Chemical Bond and the Structure of Molecules and Crystals*, 3d ed., 1959; F. O. Rice and E. Teller, *The Structure of Matter*, 1949.~~

~~Valence band~~

~~The highest electronic energy band in a semiconductor or insulator which can be filled with electrons. The electrons in the valence band correspond to the valence electrons of the constituent atoms. In a semiconductor or insulator, at sufficiently low temperatures, the valence band is completely filled and the conduction band is empty of electrons. Some of the high energy levels in the valence band may become vacant as a result of thermal excitation of electrons to higher energy bands or as a result of the presence of impurities. When some electrons are missing, the remaining ones may be redistributed among the energy levels within the valence band under an applied electric field, giving rise to an electric current. The net effect of the valence band is then equivalent to that of a few particles which are equal in number and similar in motion to the missing electrons but each of which carries a positive electronic charge. These "particles" are referred to as holes. *See* BAND THEORY OF SOLIDS; CONDUCTION BAND; HOLES IN SOLIDS; INSULATOR, ELECTRIC; SEMICONDUCTOR. [H. Y. FAN]~~

~~Valine~~

~~An amino acid considered essential for normal growth of animals. The amino acids are characterized physically by the following: (1) the pK_1 or the dissociation constant of the various titratable groups; (2) the isoelectric point, or pH at which a dipolar ion does not migrate in an electric field; (3) the optical rotation, or the rotation imparted to a beam of plane-polarized light (frequently the D line of the sodium spectrum) passing through 1 dm of a solution of 100 g in 100 ml; and (4) solubility. *See* EQUILIBRIUM, IONIC; ISOELECTRIC POINT; OPTICAL ACTIVITY; SPECTROPHOTOMETRIC ANALYSIS.~~



Valine

~~Physical constants of the L isomer at 25°C:~~
~~pK_1 (COOH): 2.32; pK_2 (NH_3^+): 9.62~~
~~Isoelectric point: 5.96~~
~~Optical rotation: $[\alpha]_D(H_2O)$: +5.6; $[\alpha]_D$(5 N HCl): +28.3~~
~~Solubility (g/100 ml H_2O): 8.85~~

~~The biosynthetic precursor, as well as the deamination product of valine, is α-ketoisovaleric acid. It is also a precursor of leucine and of the pantoic acid moiety of pantothenic acid.~~

~~Valine is biosynthesized from pyruvic acid. Most or all of the enzymes concerned also catalyze the analogous reactions in isoleucine biosynthesis. *See* AMINO ACIDS; ISOLEUCINE.~~

~~During metabolic degradation the first steps are the deamination and oxidative decarboxylation to form isobutyrylcoenzyme A (isobutyryl-CoA). The final steps in metabolic degradation (see illustration) are the conversion of isobutyryl-CoA to CO_2 and propionyl-CoA by the formation of the following compounds: methacrylyl-CoA, β-hydroxyisobutyryl-CoA, and methylmalonic acid semialdehyde. [EDWARD A. ADELBERG]~~

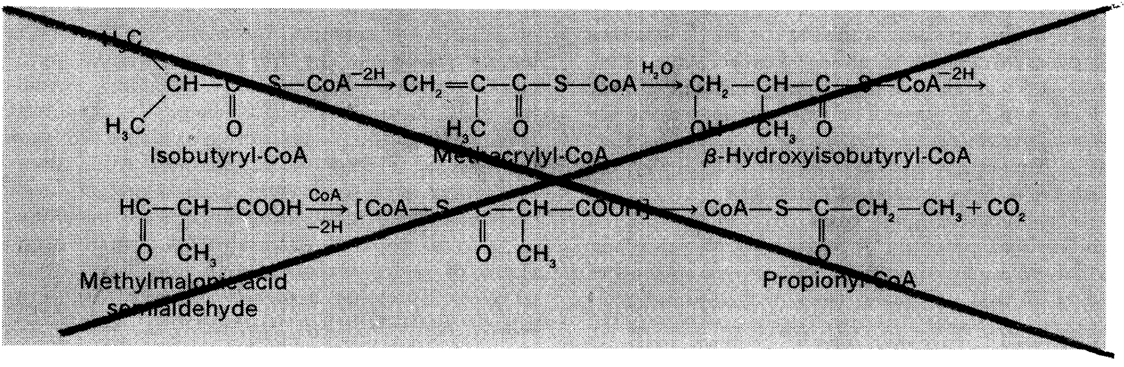
Value engineering

The systematic application of recognized techniques which identify the function of a product or service, establish a monetary value for the function, and provide the necessary function reliably at the lowest overall cost. Terms such as value analysis and value control are synonymous with value engineering.

Application. Value engineering can be applied by the individual working alone on a project or by a number of people working as a team and meeting at scheduled intervals. A team usually comprises three to five people who represent different functions within the company.

Location of the value engineering function within companies varies widely by type of industry, company organization, management interest, and so on, and by the types of tasks assigned to the value engineer or value engineering group. The function is usually assigned one or more of the following jobs: prepare and conduct value engineering training seminars, administer cost improvement programs, and apply value engineering techniques to selected projects on a full-time basis.

The methodology can be applied at any point — from initial design to full production — in the



Final steps in the metabolic degradation of valine.

life cycle of a product. Although value engineering is a problem-solving approach which can be applied to almost anything that affects profit, such as products, processes, systems, and services, it is most used as a product-oriented rationalization.

Value engineering is a supplement to, not a substitute for, other cost-reduction techniques because of the following reasons: (1) It relates value to function. The heavy orientation toward definition and analysis of function—the purpose to be served—basically distinguishes value engineering from all other cost-reduction activities. (2) It is more systematic than many other cost-reduction efforts. Value engineering is an organized approach, implemented by a specific plan.

Function. Value-oriented individuals work with functions in the same way that mathematicians work with numbers and bricklayers work with bricks. Functions are considered to be anything that makes a product work or sell. They are defined by using a verb and a noun, for example, produce heat, support weight, and fasten parts. Since function names are verbal abstractions, they lack specifications and thus greatly stimulate creativity. Throughout a value engineering study, functions are used as common denominators for unifying such variables as costs, specifications, and alternate designs.

The functional approach results in simplification of the product. The emphasis is to design a part which will perform a number of functions, instead of taking one function and causing it to be performed by many parts. Since redundancy of function is guarded against, inherent reliability is usually increased and costs are lowered.

Job plan. The organized approach adopted by value engineers is called the job plan. Job plans, although varying in some degree, are formal, step-by-step procedures which aid problem recognition, definition, and solution. All plans are designed to provide answers to the questions: What is it? What does it do? What does it cost? What else will do the job? What does that cost?

A typical six-step job plan consists of the following phases.

Information phase. After a project is selected, all available information about it is compiled. Complete cost data are accumulated for each component that makes up the project.

Function phase. Functions are defined and structured according to specific rules. The analyst defines the basic function of the project and develops an understanding of the relationships between all other functions.

Creative phase. The familiar rules of brainstorming are applied, using verb-noun definitions of functions as problem statements. Judicial judgment is withheld. Lists of ideas are established for future reference.

Evaluation phase. Ideas obtained in the creative phase are refined. Ideas are combined and recombined until low-cost, potentially workable solutions are determined. Emphasis is placed upon evaluation of the basic function. Its value level is the base upon which costs of secondary functions are added, for essential specifications are considered one at a time for each of the functions.

Investigation phase. Alternatives are examined by means of a wide range of techniques with the purpose of further refining ideas into sound, workable solutions. In this phase, specialists are consulted. Also, the analyst reviews company and industrial standards and considers specialty products, processes, and procedures. All sources of information are carefully documented.

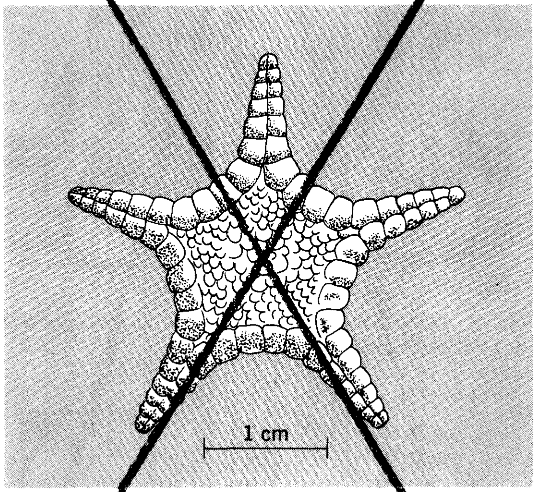
Recommendation and implementation phase. Documented recommendations are submitted to the individuals who have the responsibility for implementing the decision. A follow-up procedure is established which ensures active consideration of all recommendations.

By following the job plan the analyst redefines, or confirms, the purposes of the project, interjects cost parameters into the modification, assures evaluation of costs and performance contributions of specifications, and forces consideration of alternatives. Functional concepts, in addition to use of the job plan, help value-oriented individuals to accomplish their primary mission—providing the same or better performance at lower cost. *See* INDUSTRIAL COST CONTROL; INDUSTRIAL ENGINEERING; METHODS ENGINEERING; OPERATIONS RESEARCH; OPTIMIZATION; PROCESS ENGINEERING; PRODUCTION ENGINEERING; PRODUCTION PLANNING. [DONALD A. STILES]

Bibliography: Conover-Mast, Value analysis, 1967, in *Purchasing*, May 18, 1967; H. B. Maynard, *Handbook for Business Management*, 1967; L. D. Miles, *Techniques of Value Analysis and Engineering*, 1961; Society of American Value Engineers, *Proceedings of National Conference on Value Engineering*, 1966 and 1967; U.S. Department of Defense, Handb. no. H-111, *Value Engineering*, 1963.

Valvatina

~~A suborder of Phanerozonida in which the upper marginals lie directly over, and not alternate with, the corresponding lower marginals. The tube feet have terminal sucking disks. Paxillae may be present or lacking. The group is well represented in all existing seas from low tide to abyssal depths (see illustration). *See* ECHINODERMATA; PHANEROZONIDA. [HOWARD B. FELL]~~



~~A representative valvate starfish, *Iconaster perierctus*. (*After A.G. Fisher, 1919*)~~

Valve

A flow-control device. This article deals with valves for fluids, liquids, and gases. Valves are used to regulate the flow of fluids in piping systems and machinery. In machinery the flow phenomenon is frequently of a pulsating or intermittent character and the valve, with its associated gear, contributes a timing feature. For electrical valves *see* ELECTRON TUBE.

Pipe valves. The valves commonly used in piping systems are gate valves (Fig. 1), usually operated closed or wide open and seldom used for throttling; globe valves (Fig. 2), frequently fitted with a renewable disk and adaptable to throttling operations; check valves (Fig. 3), for automatically limiting flow in a piping system to a single direction; and plug cocks (Fig. 4), for operation in the open or closed position by turning the plug through 90° and with a shearing action to clear foreign matter from the seat.

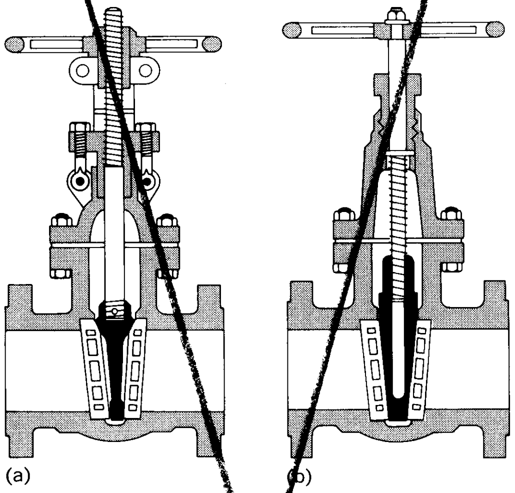


Fig. 1. Gate valves with disk gates shown in color. (*a*) Rising threaded stem shows when valve is open. (*b*) Nonrising stem valve requires less overhead.

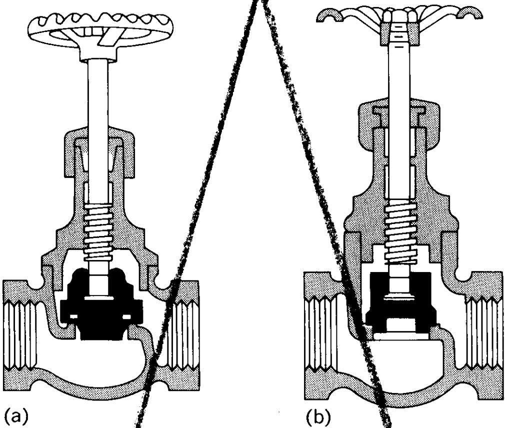


Fig. 2. Globe valves. (*a*) With gasket in disk. (*b*) With ground metal-faced disk.

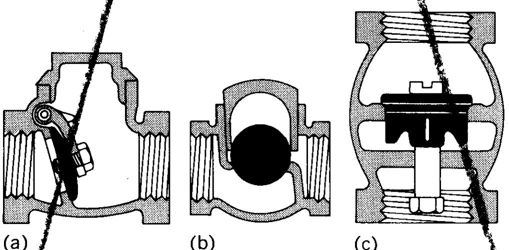


Fig. 3. Various types of straightway check valves. (*a*) Swing. (*b*) Ball. (*c*) Vertical.

Valves may have various structural features such as outside stem and yoke; packless construction; angle, as opposed to straightway flow; power instead of manual operation; and combined nonreturn and stop-valve arrangements. Valves are made in a wide assortment of materials, and a wide variety of trim, with brass or bronze for general service; cast iron for low steam pressures and temperatures (less than 250 psi) and for hydraulic pressures below 800 psi; steel and alloy steels for the highest operating pressures and temperatures (such as 5000 psi, 1200°F steam); and selected metals for chemical and process applications. Most valves are manufactured and available as hardware and comply with the requirements of the ASTM, ANSI, and ASME as to material and dimensional standards. They are variously offered as flanged, screwed, welded, sweated, or compression-fitted for connection to pipe, machinery, and fittings.

Safety and relief valves are automatic protective devices for the relief of excess pressure. They are usually rigorously specified under the legal regulations of public authorities and insurance underwriters. They must open automatically when the pressure exceeds a predetermined value; they must allow the pressure to drop a predetermined amount before closing to avoid chattering, instability, and damage to the valve and the valve seat; they must have adjustment features for both the relieving and blowdown pressures; and they must be tamperproof after setting by responsible licensed operators. *See* SAFETY VALVE.

Hydraulic turbine valves. For hydraulic turbines and hydroelectric systems, valves and gates control water flow for (1) regulation of power output at sustained efficiency and with minimum wastage of water, and (2) safety under the inertial flow conditions of large masses of water. Valve sizes are usually large (for example, 6 ft in diameter) so that power operation is necessary. Carefully streamlined construction to minimize fluid dynamic losses must be accompanied by ample provision to withstand shock and damaging effects of hydraulic inertia. Gate, butterfly (Fig. 5), telescoping, and needle constructions (Fig. 6) are variously employed. Wicket or cylinder gates regulate the flow of water to a reaction turbine at the speed ring while a governor-operated needle valve regulates flow to a Pelton impulse unit. *See* HYDRAULIC TURBINE; WATER HAMMER.

Steam-engine valves. To control the kinematics of the cycle, steam-engine valves range from simple D-slide and piston valves to multiported types. Slide valves control admission and release of steam to and from a double-acting cylinder by a single moving valve mechanism giving the necessary lap, lead, and angle of advance to accomplish the predetermined values of cutoff and compression. Multiported valves such as plug, Corliss, or poppet, valves provide four valves for a double-acting cylinder. Each valve serves a single purpose

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Please give SI units and also Customary units where such usage is still prevalent.

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