

## Simplicity (an editorial)

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Consumers of research results sometimes complain of complex, fragile designs and yearn for simplicity; equally, they desire simplicity of function. Some developers are proud of "sophisticated," "state-of-the-art" designs—even if untried. Organizations tend to become increasingly complex, promulgating additional regulations in efforts to promote efficiency and prevent fraud. Advertising often promotes self-gratification, or pride, not a simple life. What are some elements of simplicity?

Finley Peter Dunne's "Mr. Dooley in Peace and in War," published in 1898, is a collection of weekly columns from the Chicago Journal. The saloonkeeper-sage comments satirically on the Spanish American War, its aftermath, and on local, national and international affairs. He displays the prejudices of the time and place, and sometimes movingly discusses human nature, aspirations, and bravery in peace and war. Dunne's Preface describes the Irish immigrants among whom Mr. Dooley was supposed to live as "a simple people." "Simple, says ye!" remarks Mr. Dooley. "Simple like th' air or th' deep sea. Not complicated like a watch that stops whin th' shoot iv clothes ye got it with wears out!"

In this era of environments, aeronautics, space shots, and sea labs, we realize all too profoundly the complexities, costs, and problems of air, blue sky, and deep sea. The Space Shuttle illustrates the value of meticulous care yet also the nagging problems of scheduling, reliability, costs, and reusing a device time after time. On a much smaller scale (and budget), rehabilitative engineering has long faced similar difficulties in developing innovations to improve the quality of daily life for severely disabled persons—with minimal maintenance.

**In mechanism**, everyone desires simplicity of design. It should bring rapid development, high reliability, low costs, suitability in all cultures and climates, minimal training, and aesthetic satisfaction. But even a simple device may fail to meet a need or may break if overloaded or misused. (Sometimes it should, to avert greater catastrophe.)

**A first principle is to eliminate** devices or components where possible; why solve a problem that can be avoided? The massive locked hip joint, molded leather socket, and medial tracks and rollers of the "tilting table" hip disarticulation prosthesis, for instance, were heavy, cumbersome, subject to breakage, and awkward to use. Walking with the usual stiff artificial knee joint was difficult and tiresome. In contrast, the free hip joint, plastic socket, and free knee joint of the Canadian hip disarticulation prosthesis permit a lighter and more sanitary prosthesis, reduced clothing wear, and better gait with less energy consumption.

In 1947, the most expensive repair category under the unique VA prosthetics service card program was repair of broken hip joints or pelvic bands of above-knee limbs. The **absence** of hip joint and

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pelvic band from the suction socket prosthesis introduced that year totally eliminated part of the problem, and greater understanding of biomechanical principles so greatly reduced stresses in hip joints and bands, when used, that wear is reduced and failures rarely occur.

The SACH (Solid Ankle, Cushion Heel) foot likewise eliminated the mechanical ankle joint and rubber bumpers controlling dorsiflexion and plantar flexion. In 1947, though, cleaning and oiling the ankle joint and replacement of bumpers had been the most common repair charge.

Compromises occur. The Bowden cable simplified construction of artificial arms by replacing pulleys, guards, and thongs. Self-contained, self-suspended myoelectrically controlled below-elbow artificial arms offer freedom from shoulder harness, and simplicity in donning and removal, but they use more complex mechanisms, require recharging, and thus far lack the limited feedback of force and position provided by a Bowden cable and harness.

**The whole field of electronics**, for many applications, has moved rapidly toward greater simplicity and reliability at lower cost, provided sufficient numbers of identical items are involved. Everyone recognizes the trends from hand-wired vacuum tube circuits through printed circuit boards and transistors to integrated circuit chips. These changes brought great reductions in bulk, weight, power consumption, and vulnerability to vibration and shock.

Increasing use of versatile microprocessors should allow a single type of compact, mass-produced, low-cost hardware to be used for control of many different devices and functions by button-touching or a change in software. The Johns Hopkins Applied Physics Laboratory search, with grant support from the National Science Foundation and Radio Shack and participation of many other organizations and individuals, was designed to stimulate interaction between disabled persons and "computerniks." Attention again is called to IEEE Computer Society's magazine "Computer", Vol. 14, No. 1, January 1981, whose theme was Computing and the Handicapped. Numerous papers at the IEEE/EMBS and the RESNA meetings, and many of the progress reports in this Bulletin, also illustrate applications of computers to simplify the problems of the disabled. Clearly there remain vast opportunities.

**Simplicity of function** has often been attained by tolerating **reliable complexity** within mechanism. The elimination of the clutch pedal and of many motions through use of the automatic transmission, which simplifies driving for both normal and disabled individuals, is an outstanding example. Our essay in BPR 10-32 also traced many others. The Mauch S-N-S

hydraulic knee control has increased the safety, confidence, and function of many thousands of above-knee amputees by allowing recovery from stumbles and simplifying descent of hills and stairs and changes of cadence.

**Greater independence simplifies the life style** of a disabled person, allowing greater freedom of choice and more flexible scheduling. Technical aids, low-force inputs to environmental controls, power mobility aids, communication systems, and (increasingly) manipulators and robotic aids are devices and systems offering such improved independence. Though there is a spectrum of increasing mechanical and electrical complexity, careful design, evaluation, quality control, and maintenance should lead to reliable, unobtrusive assistance.

**Even organizations** require careful design and prudent monitoring. The satires of Parkinson's Law and the Peter Principle are amusing but distressingly possible. Nevertheless, detailed controls to prevent waste and to account for costs may themselves become wasteful. Numerous health care plans, for example, will pay for substantial periods of expensive hospital bed occupancy (where costs supposedly can be audited) but will not pay for modest preventive measures or for much less expensive (though less supervised) home care, for an additional temporary prosthesis or for a modest premium price to ensure faster delivery of a definitive prosthesis. Unit-dose drug delivery offers greater control against drug abuse and more precise billing but seems intrinsically expensive.

Simplicity, too, offers a measure of each individual's **expectations** and manner of living. Modesty, decency, generosity, and thoughtfulness are more attractive than pomposity, arrogance, selfishness, and contempt. To quote Mr. Dooley again, "Whin Father Butler wrote a book he niver finished, he said simplicity was not wearin' all ye had on ye'er shirt-front, like a tin-horn gambler with his di'mon' stud. An' 'tis so." ■