

## THE TWENTY-TWO MOST FREQUENTLY CITED APL PUBLICATIONS — AFTERTHOUGHTS

The reflections by John C. Murphy bring to a close the series on “The Twenty-Two Most Frequently Cited APL Publications.” The articles were a collection of great diversity and high merit. They generally dealt with new ideas in active areas of research and development, presented to the scientific and engineering community for the first time. But as was pointed out by Garfield, who developed the citation assessment methodology<sup>1</sup> used by us to identify “influential” publications, citation frequency alone does not provide a wholly satisfactory perspective of the impact of any specific publication, whether in advancing a scientific field or in furthering the technical program of the establishment where it originated. For various reasons, some articles may have had an influence well beyond their citation-frequency score. I will provide a few examples to illustrate that point.

### SATELLITES AND SPACE PHYSICS

A key publication that opened the door for all subsequent APL efforts in space research, satellite engineering, and systems development was published nearly 30 years ago by Guier and Weiffenbach.<sup>2</sup> While of pivotal importance to APL, it received only scant attention in the technical literature. The authors pointed out that “...in the absence of serious refractive effects one can reasonably expect to obtain accurate orbits through an analysis of the Doppler shift of the radio signal of an Earth satellite as a function of time.” It had been shown a few months earlier in an internal memorandum by McClure,<sup>3</sup> who was familiar with the Guier-Weiffenbach work, that accurately known satellite orbits could, in turn, be used to pinpoint the position of an observer on the surface of the earth or ocean.<sup>4</sup> An important use of satellites was established, but much careful work had to be done to determine and account for refraction effects.<sup>5</sup> Several years later, greatly refined orbits and atmospheric corrections were combined in order to design an altimeter instrument with unsurpassed precision and usefulness.<sup>6</sup>

Having established a firm foothold in an important satellite development program (Transit), APL carried out a distinguished program in space research that led to the publication of several hundred articles in planetary physics, satellite oceanography, and satellite design. Several were included in the “most frequently cited” collection in Vol. 7, No. 4 of the *Johns Hopkins APL Technical Digest*.

### HIGH-SPEED PROPULSION AND COMBUSTION

In the field of high-speed propulsion, which concentrated largely on air-breathing ramjets as the engine best suited to propel payloads to supersonic speeds beyond the operating range of turbojets, the citation-frequency record did not provide a good indication of the impact of APL publications on technical progress. At the inception of the engine development in the late 1940s, a basic input to the analysis of ramjet operations was made by Rudnick.<sup>7</sup> He developed the thermodynamic principles of heated gases flowing through variable area inlets, ducts, and nozzles that provided analytical tools for determining the performance of different engine designs and fuels.

Interest in higher and higher speeds with ramjets that have been recently pushed to the limit of escape velocity required the formulation of novel and ingenious design principles. In an important article by Billig and Dugger,<sup>8</sup> a way was shown to achieve high-propulsion efficiency at hypersonic speeds. Although its citation frequency was low, the article received the Silver Medal Award from The Combustion Institute.

In support of the development of ramjets, an article by Avery and Hart<sup>9</sup> analyzed fundamental limits in combustion devices set by the finite rates of chemical reactions that heat the gases flowing through the engine. Quite apart from its usefulness for measuring the reactivity of various fuel-oxidizer combinations, the concept of a “highly stirred reactor,” by separating chemical parameters from physical processes (such as droplet evaporation and mixing), was widely adopted in the analysis of chemical engineering operations. The paper, however, has been cited rarely in the literature.

In a series of influential publications, Hart and McClure<sup>10</sup> laid the foundation for understanding the intricate couplings between sound waves and solid propellant combustion in rockets. Acoustic resonances can be highly destructive and may lead to catastrophic structural failures of propellant grains or overheating of vital structural parts. For this and a series of subsequent publications, McClure was awarded the Hillebrand Award of the American Chemical Society. The citation frequency was only moderate.

### OTHER TOPICS

A substantial number of other articles could be mentioned that did not figure prominently in the citation-

frequency analysis but that, nevertheless, influenced the fields they addressed. For example, a mathematical problem in a topology of long standing, "The Paving of the Plane" formulated by Hilbert nearly 100 years ago, was solved.<sup>11</sup> Monitoring ocean waves from space with synthetic aperture radar promises to provide a global, real-time picture of sea states everywhere on the ocean.<sup>12</sup>

## CONCLUSION

Citation-frequency analysis works well in fields where perceptive and active groups of research workers make collective judgments about the significance of individual publications. This is especially true in rapidly developing areas where new insights stimulate a large body of researchers to use them promptly. In our experience, articles of unusual pertinence and interest were identified by this method. But to bring the APL publication achievements into full perspective, particularly in engineering and technology, articles that are selected on a more qualitative basis need to be added.

Since 1985, with the participation of a knowledgeable committee, such a subjective selection process has been used at APL to identify articles that are judged to be of unusual significance.<sup>13</sup> It remains to be seen if the citation assessment that requires several years of data accumulation will agree with those selections.

## READING LIST

Arranged in six broad categories, the reading list highlights much of the unclassified research at APL during the past 40 years. It provides, in the main, survey articles of long-range individual and group efforts—some terminated, others ongoing.

Together with "The Twenty-Two Most Frequently Cited APL Publications," the list delineates areas of interest to the APL research staff. With more than 3000 publications to survey, it cannot be an exhaustive list, but it is intended to be a guide to a rich lode of accomplishments in many areas of science and engineering.

### Physics/Chemistry

#### *In the Beginning*

R. A. Alpher and R. C. Herman, "Theory of the Origin and Relative Abundance Distribution of the Elements," *Rev. Mod. Phys.* **22**, 153 (1950).

#### *Free Radicals Confined*

C. K. Jen, "Electron Spin Resonance Studies of Trapped Radicals," in *Formation and Trapping of Free Radicals*, Academic Press (1960).

#### *Unstable Chemical Fragments*

S. N. Foner and R. L. Hudson, "Mass Spectrometry of Inorganic Free Radicals," *Adv. Chem.* **36**, 34 (1962).

#### *Organ Pipes in the Sky*

F. T. McClure, "Rockets, Resonance and Physical Chemistry," *Science* **135**, 771 (1962).

## REFERENCES

- 1 E. Garfield, "Uses and Misuses of Citation Frequency," *Current Contents* **16**, 3-9 (Oct 28, 1985).
- 2 W. H. Guier and G. C. Weiffenbach, "Theoretical Analysis of Doppler Radio Signals from Earth Satellites," *Nature* **181**, 1525 (1958).
- 3 F. T. McClure, *Satellite Doppler as a Means of Ship Navigation*, JHU/APL Internal Memorandum (Mar 18, 1958); see also *Proposal for a Satellite Doppler Navigation System*, JHU/APL TG 305 (1958).
- 4 H. D. Black, "The Transit System, 1977: Performance, Plans and Potential," *Philos. Trans. R. Soc. (London)* **A294**, 217 (1980).
- 5 H. S. Hopfield, "The Effect of Tropospheric Refraction on the Doppler Shift of a Satellite Signal," *J. Geophys. Res.* **68**, 5157 (1963).
- 6 J. Goldhirsh, "Tutorial Assessment of Atmospheric Height Uncertainties for High-Precision Satellite Altimeter Missions to Monitor Ocean Currents," *IEEE Trans. Geosci. Remote Sensing* **68**, 418 (1982). (Best Transaction Paper Award, IEEE Geoscience and Remote Sensing Society.)
- 7 P. Rudnick, "Momentum Relations in Propulsive Ducts," *J. Aeronaut. Sci.* **14**, 540 (1947).
- 8 F.S. Billig and G. L. Dugger, "The Interaction of Shock Waves and Heat Addition in the Design of Supersonic Combustors," in *Proc. Twelfth Symp. on Combustion* (1966). (Silver Medal Award, The Combustion Institute.)
- 9 W. H. Avery and R. W. Hart, "Combustion Performance with Instantaneous Mixing," *Indust. Eng. Chem.* **45**, 1634 (1953).
- 10 R. W. Hart and F. T. McClure, "Combustion Instability: Acoustic Interaction with a Burning Propellant Surface," *J. Chem. Phys.* **30**, 1501 (1959). (Hillebrand Award, Washington Section, American Chemical Society.)
- 11 R. B. Kershner, "On Paving the Plane," *Am. Math. Mon.* **75**, 839 (1968).
- 12 R. C. Beal, "Spaceborne Imaging Radar: Monitoring of Ocean Waves," *Science* **208**, 1373 (1980); see also *Proc. Symp. Measuring Ocean Waves from Space*, *Johns Hopkins APL Tech. Dig.* **8**, 1-147 (1987).
- 13 W. G. Berl, "Writing Awards," *Johns Hopkins APL Tech. Dig.* **8**, 154-155 (1987).

### *Fast Reactions of Molecular Fragments*

A. A. Westenberg, "Applications of Electron Spin Resonance to Gas-Phase Kinetics," *Science* **164**, 381 (1969).

### *Chemical Switches*

R. S. Potember, R. C. Hoffman, and T. O. Poehler, "Molecular Electronics," *Johns Hopkins APL Tech. Dig.* **7**, 129 (1986).

### *Unsteady Planetary Rotations*

R. R. Newton, "The Secular Acceleration of the Earth's Spin," *Geophys. J. R. Astron. Soc.* **80**, 313 (1985).

## Space/Satellite Systems

### *First Steps into Space*

J. A. Van Allen, "Exploratory Cosmic Ray Observations at High Altitudes by Means of Rockets," *Sky and Telescope* **7** (1948).

### *Currents in Space I*

T. A. Potemra, "Magnetospheric Currents," *Johns Hopkins APL Tech. Dig.* **4**, 276 (1983).

### *Currents in Space II*

D. J. Williams, "The Earth's Ring Current: Causes, Generation and Decay," *Space Sci. Rev.* **34**, 223 (1983).

### *Planetary Magnetic Fields*

L. J. Lanzerotti and S. M. Krimigis, "Comparative Magnetospheres," *Johns Hopkins APL Tech. Dig.* **7**, 335 (1986).

### *Satellite Altimetry*

C. C. Kilgus et al., "GEOSAT," *Johns Hopkins APL Tech. Dig.* **8**, 169 (1987).

## **Oceanography**

### *Waves Everywhere*

R. C. Beal et al., "Measuring Ocean Waves from Space," *Johns Hopkins APL Tech. Dig.* **8**, 1 (1987).

### *Waves Across the Seas*

J. R. Apel, J. R. Holbrook, A. K. Liu, and J. J. Tsai, "The Sulu Sea Internal Wave Experiment," *J. Phys. Oceanogr.* **15**, 1625 (1985).

## **Engineering**

### *Limits to Attacks*

W. H. Goss, "Guided Missiles," Transcript of address delivered to the joint meeting of the Engineers Club of Philadelphia and the Philadelphia Section, American Society of Mechanical Engineers (Feb 21, 1950).

### *Limits to Growth*

F. N. Frenkiel, "Atmospheric Pollution and Zoning in an Urban Area," *Sci. Monthly* **82**, 194 (1956).

### *From Mach 5 to Orbital Velocity*

W. H. Avery, "Beyond the Supersonic Transport," *Science and Technology*, 40 (Feb 1968).

### *Unseen Hazards*

T. G. Konrad, "The Dynamics of the Convection Process in Clear Air as Seen by Radar," *J. Atmos. Sci.* **27**, 1138 (1970).

### *Inexhaustible Energy from the Sun*

G. L. Dugger, H. L. Olsen, W. B. Shippen, E. J. Francis, and W. H. Avery, "Floating Ocean Thermal Power Plants and Potential Products," *J. Hydronaut.* **9**, 129 (1975).

### *Electromagnetic Propagation Anomalies*

H. W. Ko, J. W. Sari, and J. P. Skura, "Anomalous Microwave Propagation through Atmospheric Ducts," *Johns Hopkins APL Tech. Dig.* **4**, 12 (1983).

### *Unsnarling Traffic*

R. A. Makofski, "The Future of Urban Transportation," *Johns Hopkins APL Tech. Dig.* **3**, 278 (1982).

## **Biomedicine**

### *The Urban Fire Problem*

W. G. Berl and B. M. Halpin, "Fire Related Fatalities: An Analysis of Their Demography, Physical Causes and Medical Consequences," in *Fire Standards and Safety*, American Society for Testing Materials, 614 (1977).

### *Pain*

R. A. Meyer and J. N. Campbell, "Peripheral Neural Coding of Pain Sensation," *Johns Hopkins APL Tech. Dig.* **2**, 162 (1981).

### *Paraplegic Aids*

W. Seamone and G. Schmeisser, "New Control Techniques for Wheelchair Mobility," *Johns Hopkins APL Tech. Dig.* **2**, 179 (1981).

### *Flows in Biological Pipes*

M. H. Friedman, "Geometric Risk Factors for Arteriosclerosis," *Johns Hopkins APL Tech. Dig.* **4**, 85 (1983).

### *Information Networking in Hospitals*

B. I. Blum, "Information Systems at the Johns Hopkins Hospital," *Johns Hopkins APL Tech. Dig.* **4**, 104 (1983).

### *Outer Space to Inner Space*

R. E. Fischell, "Microcomputer-Controlled Devices for Human Implantation," *Johns Hopkins APL Tech. Dig.* **4**, 96 (1983).

### *A Cancer Cure*

J. G. Parker, "The Importance of Singlet Delta Oxygen in Cancer Photoradiation Therapy," *Johns Hopkins APL Tech. Dig.* **5**, 48 (1984).

### *Eye Damage*

R. L. McCally, R. A. Farrell, C. B. Barger, H. A. Kues, and B. F. Hochheimer, "Nonionizing Radiation Damage to the Eye," *Johns Hopkins APL Tech. Dig.* **7**, 73 (1986).

## **Miscellaneous**

### *The R&D Business*

R. E. Gibson, "A Systems Approach to Research Management," *Res. Manag.* **5**, 215 (1962).

### *The Struggle for World Leadership*

R. A. Roberts and F. T. McClure, "Arms, Arms Control and Foreign Policy," *J. Arms Control* **1**, 163 (1963).

### *Ancient Astronomical Measurements*

R. R. Newton, "Two Uses of Ancient Astronomy," *Phil. Trans. R. Soc. (London)* **A276**, 99 (1974).